FRESCO USER MANUAL

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1. INTRODUCTION

FRESCO is an easy to use business graphics package which will produce a variety of common business application graphs on a number of graphics display devices.

FRESCO is designed for the APL user with little or no programming experience. A succinct collection of functions allows you to specify output options such as **plot style**, **axes**, **titles**, and **line color**. Complex graphs are built from simpler component graphs.

2. HOW MUCH APL BACKGROUND YOU NEED

FRESCO is for users who may have a very basic knowledge of the APL programming language, as well as for experienced programmers. To use FRESCO, you will need to know how to:

assign a value to a variable.

form vectors and matrices (perhaps with the APL functions catenate, laminate, and reshape).

convert numeric data to character (using one or more APL formatting functions).

execute a defined function.

write a simple APL function and use the APL function definition mode.

)LOAD and)SAVE a workspace.

Additionally, you will need to know the different data structures in APL (scalars, vectors, and matrices) and you will need to know how to select wanted elements from these data structures.

3. HOW TO READ THIS DOCUMENT

This document contains examples of APL expressions you can use in FRESCO. When APL is ready to accept an expression, the cursor is indented six spaces. Likewise, the examples of APL expressions in this document are indented six spaces.

APL functions and variables are shown in this document as upper case. For example, you can display a list of the FRESCO options in effect by using the STATE function as follows:

```
      STATE
```

Examples of APL displays appear in this document beginning at the left margin following the APL expression which produces them. For example, the use of the STATE function and its resulting display when the DEFAULT state is in effect is shown as follows:

```
      STATE
STYLE 'LINEPLOT'
AREA 1.5 1.5 8.5 6.5
PAGE 10 7.5
1 PENS 1 2 3 4 5 6
'A' SIZE 0.2
'A' DIST 0.25
'YL'DIST 1
'YR'DIST 1
'XT'DIST 1
'XB'DIST 1
'L' DIST 0.7 ¯0.4
'T' DIST 1
'R' DIST 0
'C' SIZE 0.1 0.2
'T' SIZE 0.2 0.4
SHOW ON
```

The examples in this document show values which may be used with APL functions. There are two kinds of values, character values and number values. Here is an example of the expression for choosing the 'PIECHART' style of plotting by using the STYLE function with the character value 'PIECHART':

```
      STYLE 'PIECHART'
```

Number values are lists of one or more numbers. For example, this expression sets the size of the PAGE in FRESCO to the two numbers 10 and 7.5, representing the width and height of the PAGE:

```
      PAGE 10 7.5
```

The explanation of each FRESCO function begins with a **syntax statement**. The syntax statement describes the kinds of values that you can use with the function. For example, here is a syntax statement for the STYLE function:

```
STYLE <plot style>
```

This statement means that the STYLE function is used with a class of values called <plot style>. The syntax statement will be followed by an explanation of the permissible values of <plot style> and their meaning.

The syntax statement may contain a list of values or classes. In that case, the list is enclosed in square brackets and each alternative value or class is separated by '|'. For example,

```
<axis> LIMS [ON|OFF|<range>]
```

means that the LIMS function accepts a class of values called <axis> as the left argument and either ON, OFF, or a class of values called <range> as the right argument.

Examples of displays also contain references to classes or lists of values. In the following example, the use of the STYLE function with the value '' results in the display of the current plot style setting:

```
      STYLE ''
<plot style>
```

4. IDENTIFYING SPECIAL TERMS USED IN THIS DOCUMENT

This document uses certain words or phrases that have specialized meanings. These terms are **highlighted.** The specialized meaning is explained when they are first used. For example, the term **device space** refers to the total area a particular graphic device is capable of drawing.

When discussing a FRESCO function or the features it represents, the name of the function is in upper case. For example, the STYLE function selects the plot style. Keywords used as arguments to functions are enclosed in single quotes. For example, 'LINEPLOT' is one of the STYLE options.

5. COMPONENTS OF THE GRAPH

A graph consists of a number of **components.** This document uses special terms for these components. Each particular graphic device has physical limits on the size of drawings it can make. The physical limits of the graphic device are called the **device**

space. You may use all or part of the device space when drawing a graph. For example, you may draw on a piece of paper which is smaller than the device space. Or, you may wish to draw the graph on a portion of the paper. The part of the device space which contains the graph is called the **PAGE**.

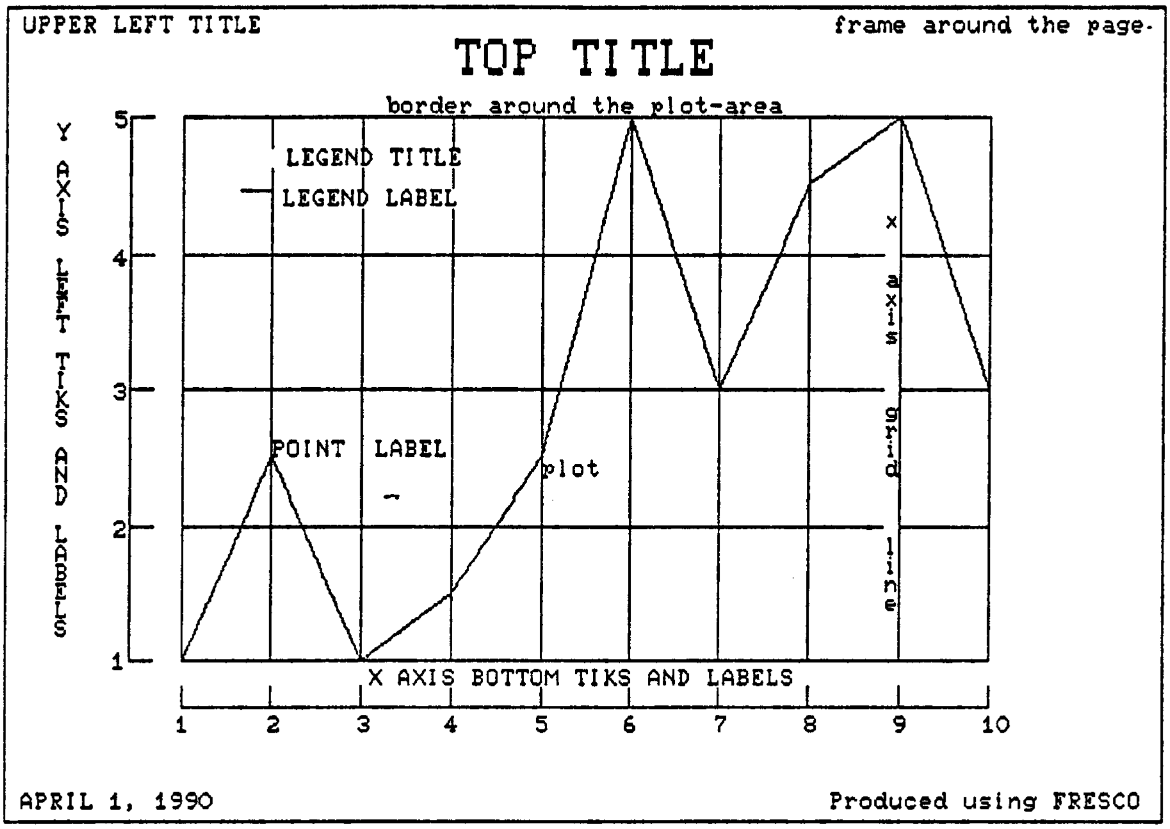
The term **plot** refers to the **points**, **curves**, **bars**, etc. that depict numeric values. The part of the PAGE which contains the plot is called the **plot area**, or **AREA** for short. The part of the PAGE outside the AREA is called the **margin**.

In addition to the plot, the PAGE may also contain the following:

TITLE	character names and phrases that describe the plot.
TIKS	marks on a line (like a ruler) that show the vertical or horizontal position of certain values.
LABEL	numbers or character names that show the values or meaning of quantities represented by the plot.
FRAME	a box drawn around the PAGE.
BORDER	a box drawn around the AREA.
BASE	a horizontal line drawn at the zero y value of the plot.
GRID	horizontal or vertical lines drawn through the plot representing certain values (like the lines on graph paper).
DIVIDER	horizontal or vertical lines drawn anywhere on the PAGE.
LEGEND	a key describing the meaning of each plot, used to identify multiple plots superimposed on the same graph.

Most components of the graph are drawn relative to the location of the **AREA**. The **FRAME** and **corner titles**, however, are drawn relative to the PAGE.

EXAMPLE 1 shows how these components appear on a typical graph.



EXAMPLE 1: COMPONENTS OF THE GRAPH

6. REFERENCES TO HORIZONTAL AND VERTIAL DIMENSIONS

The graph has two **dimensions, horizontal** and **vertical.** The horizontal dimension is called the **x axis**, and the vertical dimension is called the **y axis**. These terms are used in this document to locate components, such as **ticks** and **labels,** that can be located on one axis or the other.

7. GETTING STARTED

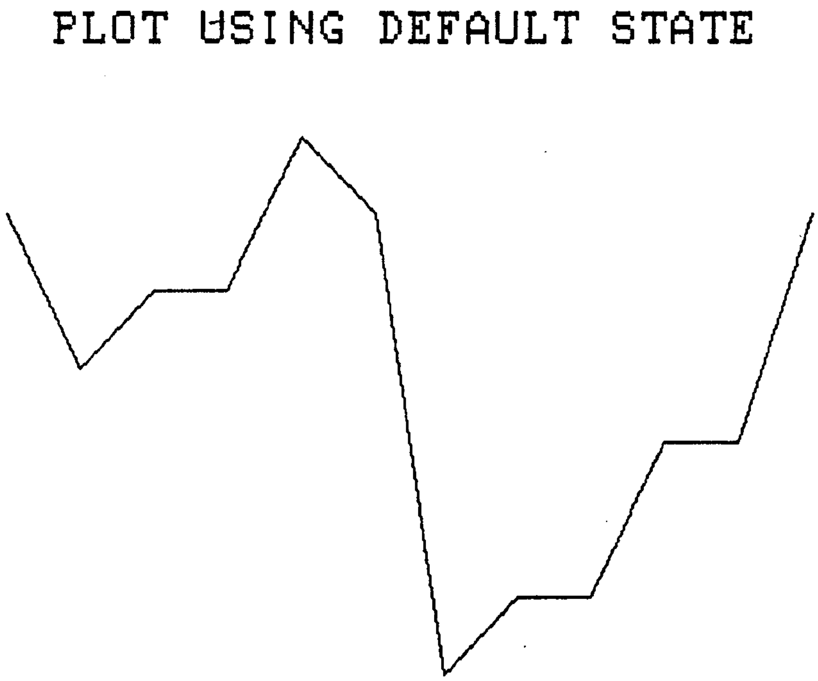
FRESCO uses the APL programming language. To use FRESCO, you load the FRESCO workspace using the following command:

```
      )LOAD <library> FRESCO
SAVED <time stamp>
```

where <library> is the library number where the FRESCO workspace is saved and <time stamp> is the date and time when the FRESCO workspace was last saved.

You can use functions to select which components to include in the graph, or to change the size, location, style, and content of components of the graph. These options are called, collectively, the **state**. The functions which change the options are called **state setting functions**, or simply, **state settings**. The **STATE** function displays the current value of any options in effect. The syntax is,

```
      STATE
<state settings>
```



EXAMPLE 2: PLOT USING DEFAULT STATE

You draw the graph using the **PLOT** function. The state in effect when you use the PLOT function controls the appearance of the graph. Here is the syntax of PLOT:

```
PLOT <plot data>
```

where <plot data> contains the numbers to plot. The simplest way to use PLOT is where <plot data> is a vector, as in EXAMPLE 2. EXAMPLE 2 draws a plot with 12 points along the x axis, having the values in the variable named IBM on the y axis.

8. FRESCO STATE SETTINGS

FRESCO options are selected by using state setting functions. A single state setting function will allow selection from a family of options. For example, the STYLE function allows you to set the **plot style** to any of several types.

When you use state settings, the options you select remain in effect in the workspace until you change them. This makes it easy to draw more than one graph using the same state. You can set the state once and then use the PLOT function multiple times. By using PLOT multiple times with the same values, you draw the identical graph over again, making multiple copies of the same graph. You can also use PLOT multiple times with different values, keeping the state settings the same for each graph but changing the plot values. Or, you can use one or more state settings between each use of the PLOT function to change the state for each graph.

All state setting functions take the empty vector '' as a value. This causes the state setting function to return the current setting. For example,

```
      STYLE ''
<plot style>
```

where <plot style> is the current style setting. State setting functions which only take **ON** or **OFF** as a right argument return the value 1 for ON and 0 for OFF. When specifying states, state setting functions return a null matrix.

The **DEFAULT** function sets all states to the options in effect when the FRESCO workspace was first loaded. The DEFAULT function can be modified to select any plotting options as the default. The **STATE** function displays the state settings in effect.

SUGGESTION: When you define your own functions to set states and produce plots, it is best to use the DEFAULT function at the beginning of your function. That way, the state settings will start out the same every time the function is used, regardless of what state settings were used previously.

Some state setting functions accept a **text specifier** as an argument. A text specifier consists of one or more **text lines**, and is one of the following:

a numeric vector, where each number is a text line.

a character vector that is split into one or more substrings, each of which is a text line; the first element of the vector is a **delimiter**, and each string is prefixed by and does not include the delimiter.

a character matrix, where each row of the matrix is a text line.

a nested vector of character vectors, where each nested element is a text line.

9. THE PLOT FUNCTION

The **PLOT** function sends commands to the **device** to draw the graph. You use the PLOT function with a value, as follows:

```
PLOT <plot data>
```

where <plot data> is a vector or matrix of numbers. When <plot data> is a vector, the PLOT function draws one plot. When <plot data> is a matrix, the PLOT function draws **multiple plots** superimposed on the same graph, one for each column of the matrix (except 'PIECHART' and 'HILOCLOSE' plot styles).

When <plot data> is a matrix, the order of the columns of <plot data> corresponds to the order that **PENS** and **EFFECT** parameters apply. With the **'HISTO3'** plot style, it is the order in which **histogram bars** are drawn side by side.

For the PIECHART plot style, each element of a vector of values in <plot data> controls the size of one slice of the pie. The order of elements in the vector controls the order of the slices around the pie, and the order in which PENS and EFFECT parameters apply. When <plot data> is a matrix, the second column controls the distance each corresponding slice is exploded from the pie.

10. DIMENSIONS

All **dimensions** in FRESCO are given in inches. If desired, FRESCO can be modified to accept dimensions in centimeters.

11. SIZE AND LOCATION OF GRAPH (PAGE, AREA)

The **PAGE** and **AREA** functions control the size of the graph and the **plot area**, which determines the placement of the **plot**, **plot text**, and **plot markings** such as **TIKS** and **GRID**. In general, the PAGE setting represents the space available for drawing all components of he graph. The AREA function sets the size and location of the plot, plot text, and plot markings.

The syntax of PAGE is

```
      PAGE <page size>
      PAGE ''
<page size>
```

where <page size> is a two element vector representing the **x axis** and **y axis** size of the PAGE. For example, this expression sets the PAGE size to **landscape** orientation with x axis length 10 inches and y axis length 7.5 inches:

```
      PAGE 10 7.5
```

The following expression sets a **portrait** PAGE size 7.5 inches wide and 10 inches high:

```
      PAGE 7.5 10
```

The PAGE function controls the placement of the following:

corner TITLE

FRAME

DIVIDER

The syntax of the AREA function is

```
      AREA <area size>
      AREA ''
<area size>
```

where <area size> is a four element numeric vector representing the x axis and y axis lower left coordinates, and the x and y axis upper right coordinates, of the AREA. For example, here is how you create a 1.5 inch margin around the AREA where the PAGE is 10 inches wide and 7.5 inches high:

```
AREA 1.5 1.5 8.5 6
```

The AREA function controls the placement of the following:

PLOT

TIKS

LABEL

'T' TITLE

LEGEND

BASE

BORDER

GRID

SUGGESTION: Be sure the AREA setting is within the space set for PAGE. Otherwise, the graph components controlled by PAGE (corner titles, FRAME, etc.) will overlap the plot.

12. PLOT STYLE

The **STYLE** state setting function allows you to select which **plot style** to use. The syntax of STYLE is

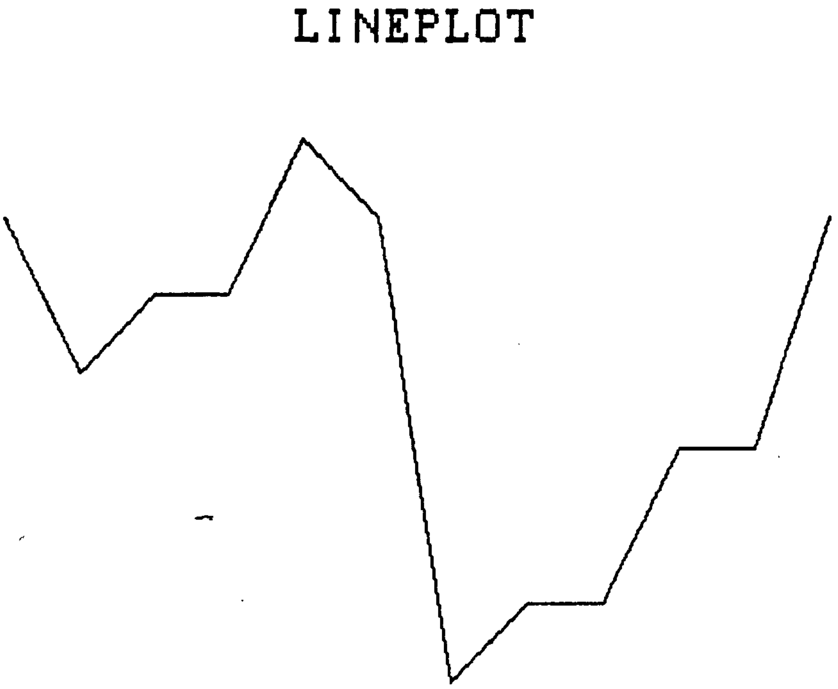
```
      STYLE <plot style>
      STYLE ''
<plot style>
```

The following options are available:

'LINEPLOT'	straight line between plot points.
'SQUAREPLOT'	the top outline of a histogram.
'HISTO1'	histogram where the width of each bar extends to the adjacent bar.
'HISTO2'	histogram where each bar is placed on top of the previous bar.
'HISTO3'	histogram where each bar is drawn to the side of a previous bar.

'HISTO4'	histogram tops only; no vertical lines.
'HISTO5'	vertical line histogram; the vertical lines of the bars are drawn without the tops.
'HILOCLOSE'	high/low/close stock market type plot.
'PIECHART'	pie chart.
'SCATTERGRAM'	scattergram; draws plot points only.
'OBJECT'	arbitrary drawing specified by a matrix of x,y coordinate pairs.

The following sections explain each of these plot styles more fully.



EXAMPLE 3: LINEPLOT

12.1 STYLE 'LINEPLOT'

'LINEPLOT' draws a straight line between plot points. When you use the 'LINEPLOT' style setting to plot a vector, the **x axis values** are iota the length of the vector and the **y axis values** are the corresponding number. EXAMPLE 3 shows the plot of a 12 element vector.

When **PLOT** is used with a matrix of values, each column is drawn as a separate plot superimposed on the same graph. EXAMPLE 27 shows a 'LINEPLOT' produced by plotting a matrix of values.

You can specify the x axis values explicitly by using the **XCOL** state setting. They syntax of XCOL is

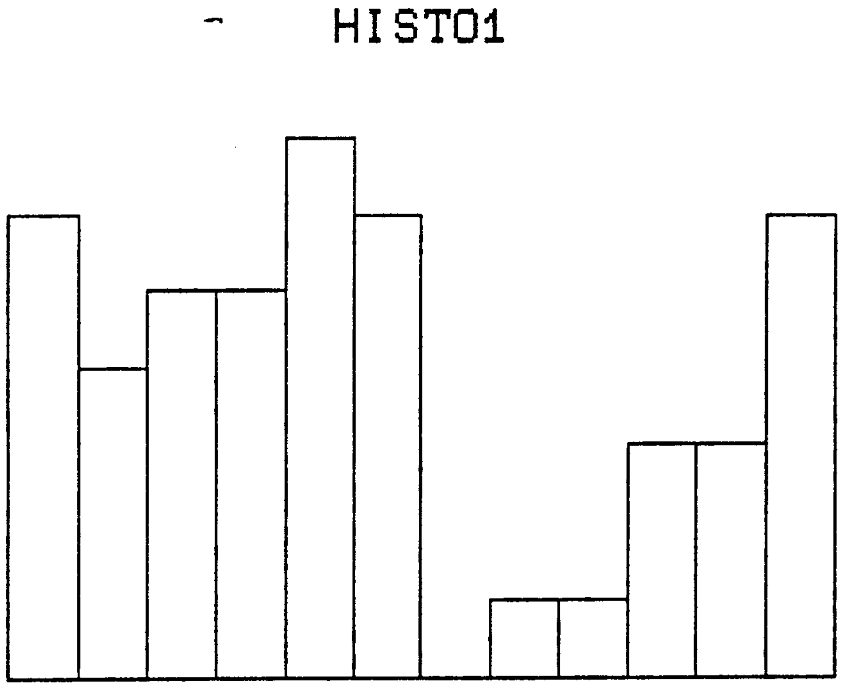
```
     XCOL [ON|OFF]
     XCOL ''
[0|1]
```

With XCOL ON, the first column of the PLOT argument is used for the x axis values, and the remaining columns are used for y axis values. EXAMPLE 25 shows a 'LINEPLOT' produced with XCOL ON.

You can specify six styles of **histograms**: 'HISTO1', 'HISTO2', 'HISTO3', 'HISTO4', 'HISTO5', and 'SQUAREPLOT'. A histogram is derived from rectangles with height equal to y axis values.

12.2 STYLE 'HISTO1'

'HISTO1' is a histogram where the width of each rectangle extends to the adjacent rectangle. EXAMPLE 4 is a sample of this plot style.



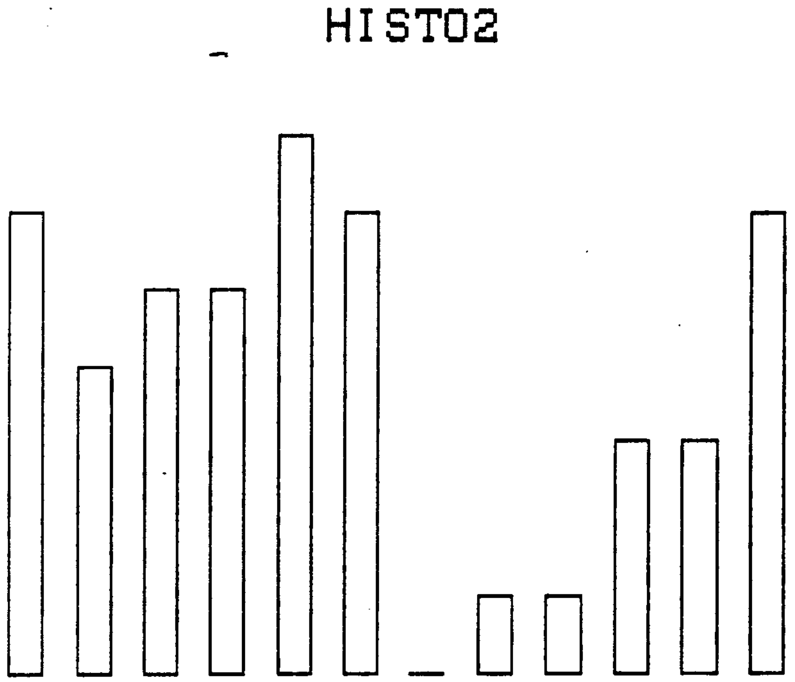
EXAMPLE 4: HISTO1

When overlaying **multiple plots** with 'HISTO1', you normally plot the **cumulative sum** of the corresponding y axis values of each plot in order to stack the rectangles for each plot on top of each other. EXAMPLE 16 shows this approach. Stacked bars, like 'PIECHART', represent the components and the sum of a total entity.

You can explicitly specify the x axis values with 'HISTO1' to change the width of each rectangle.

12.3 STYLE 'HISTO2'

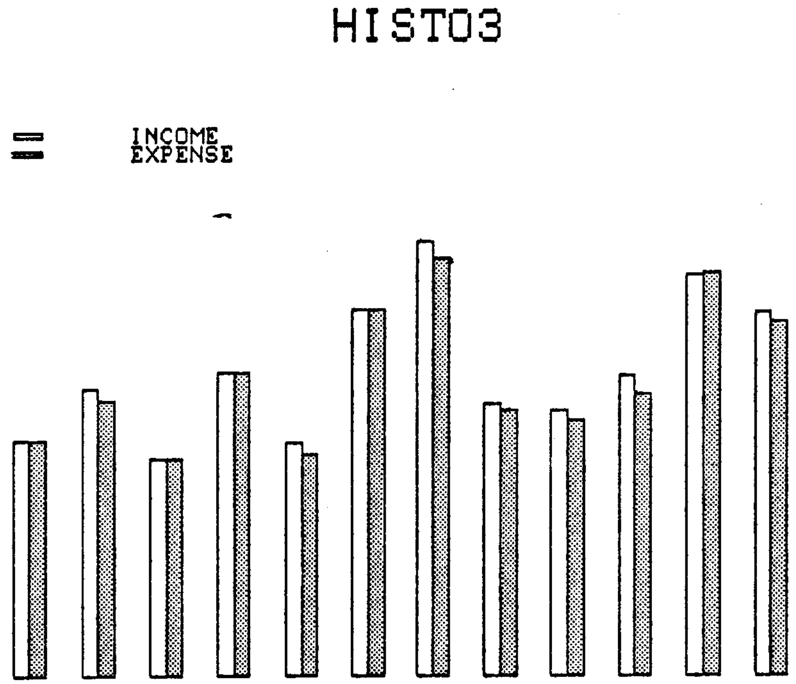
'HISTO2' is a histogram where the width of each rectangle is half the distance between x axis values. This leaves space between each rectangle, as shown in EXAMPLE 5. You can stack plots and specify the x axis values as with 'HISTO1'.



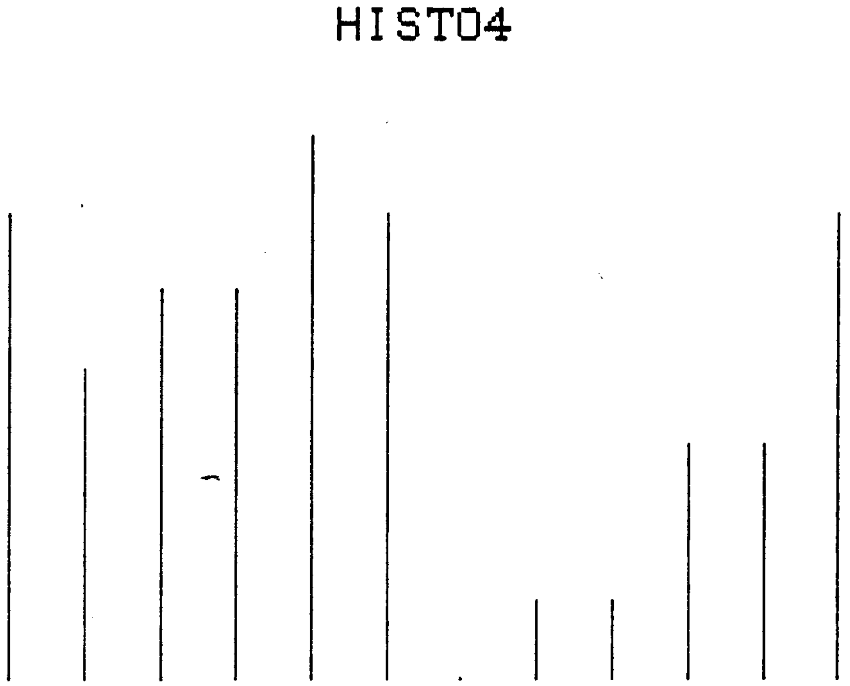
EXAMPLE 5: HISTO2

12.4 STYLE 'HISTO3'

'HISTO3' is a histogram with space between each rectangle similar to 'HISTO2'. When overlaying plots with a matrix argument in a **multiple plots**, however, a separate rectangle is drawn side by side for each column of plot data. This is shown in EXAMPLE 6.



EXAMPLE 6:HISTO3



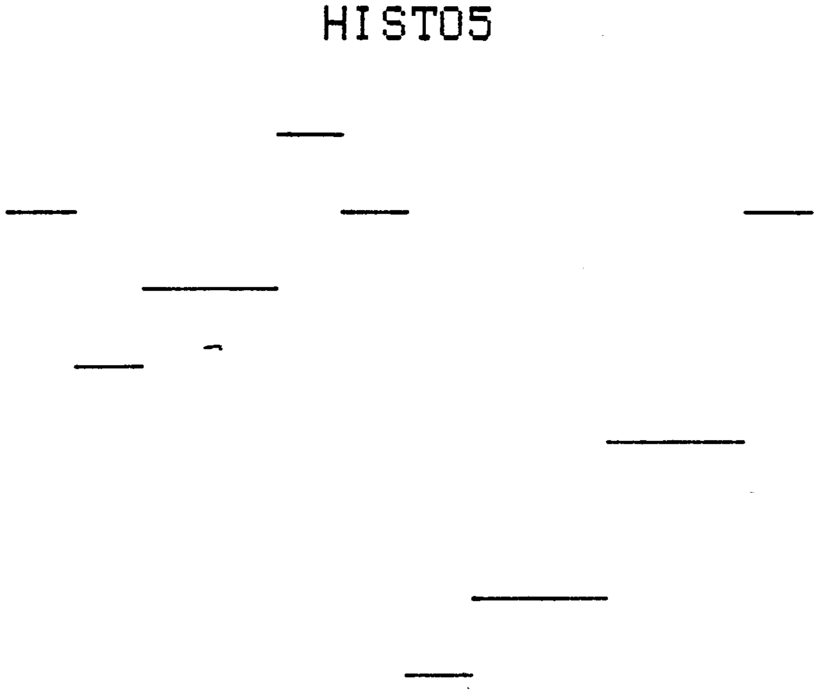
EXAMPLE 7: HISTO4

12.5 STYLE 'HISTO4'

'HISTO4' is a vertical line histogram. Only the left vertical side of the rectangle is drawn. EXAMPLE 7 demonstrates this plot style.

12.6 STYLE 'HISTO5'

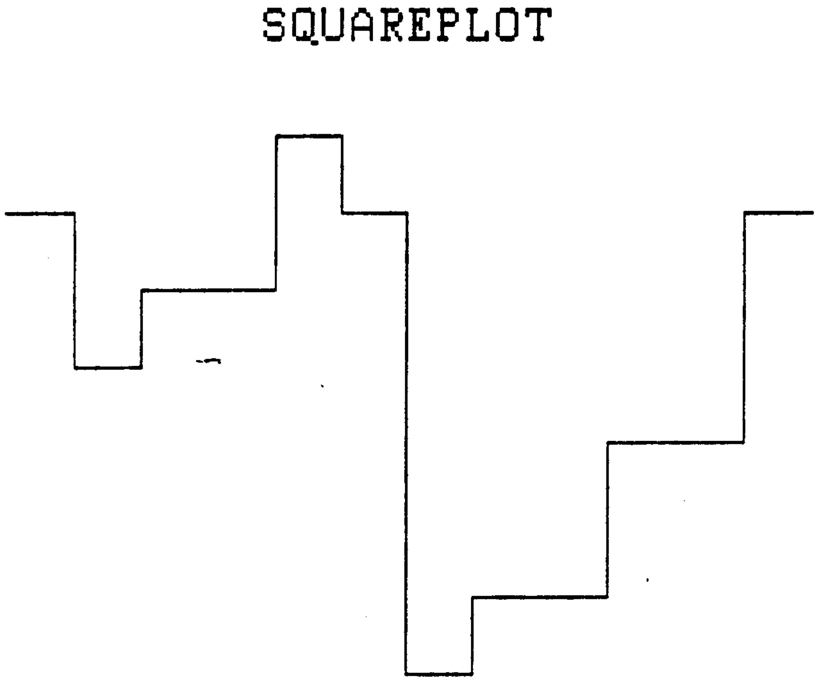
'HISTO5' draws histogram tops only. All vertical lines are omitted. This is shown in EXAMPLE 15.



EXAMPLE 8: HISTO5

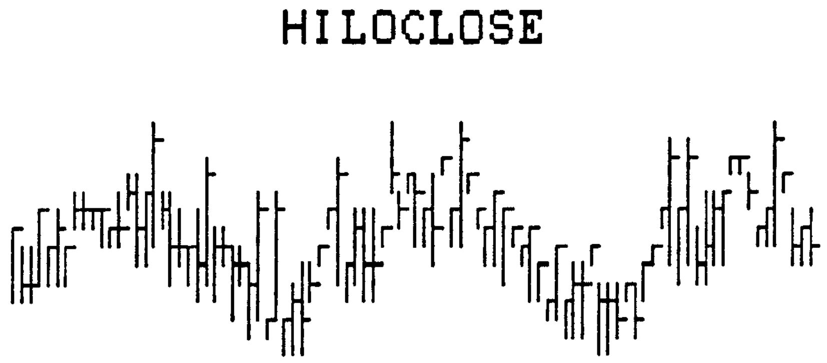
12.7 STYLE 'SQUAREPLOT'

'SQUAREPLOT' draws the top outline of a histogram, as shown in EXAMPLE 9.



EXAMPLE 9: SQUAREPLOT

12.8 STYLE 'HILOCLOSE'

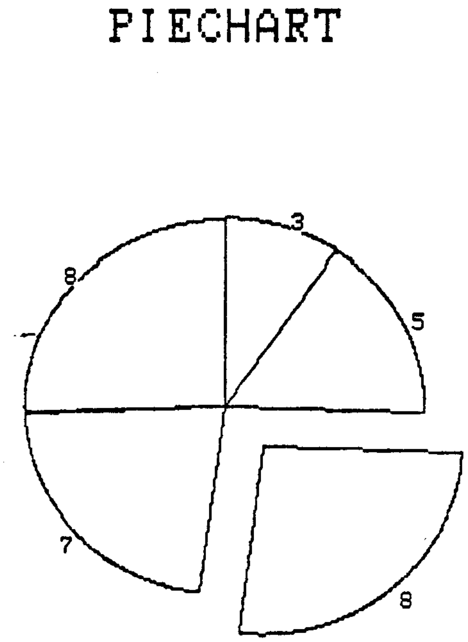


EXAMPLE 10: HILOCLOSE

'HILOCLOSE' is a high/low/close stock market type plot. This plot style requires a three column matrix of numbers. The first column is the high value, the second column is the low value, and the third column is the closing value. A vertical line is drawn between the high and the low value, and a horizontal line is drawn at the closing value. A sample of this plot style is shown as EXAMPLE 10.

12.9 STYLE 'PIECHART'

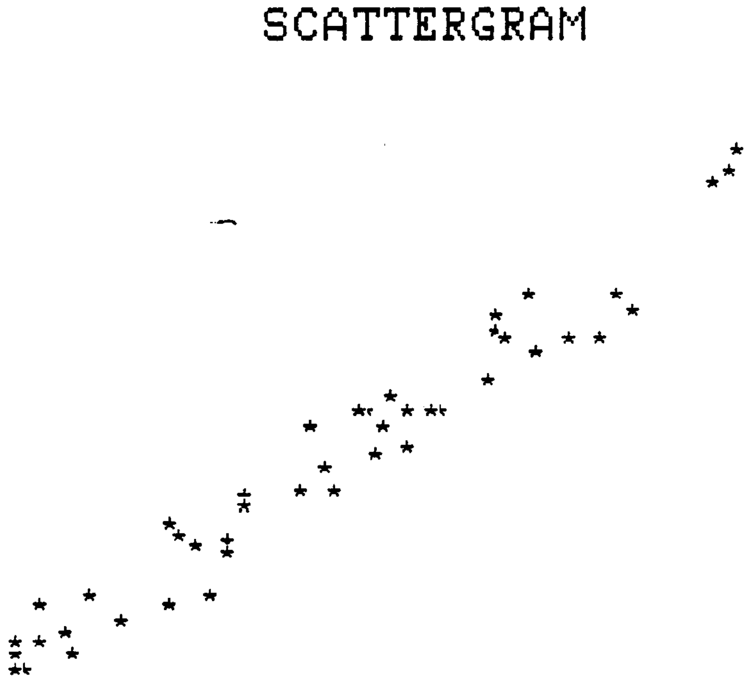
A **'PIECHART'** is a circle divided into radial sections, or slices, where each section represents a portion of some whole entity. A sample 'PIECHART' is shown as EXAMPLE 11.



EXAMPLE 11: PIECHART

12.10 STYLE 'SCATTERGRAM'

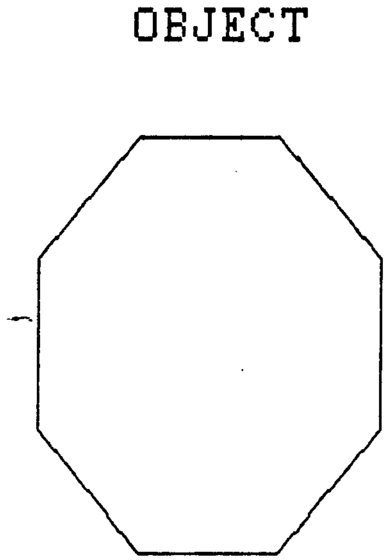
A 'SCATTERGRAM' is a plot of points only. You can use it to depict the relationship between dependent and independent statistical variables by specifying the x values as the independent variable and the y axis values as the dependent variable. An example of a survey plot using the scattergram plot style is shown as EXAMPLE 12.



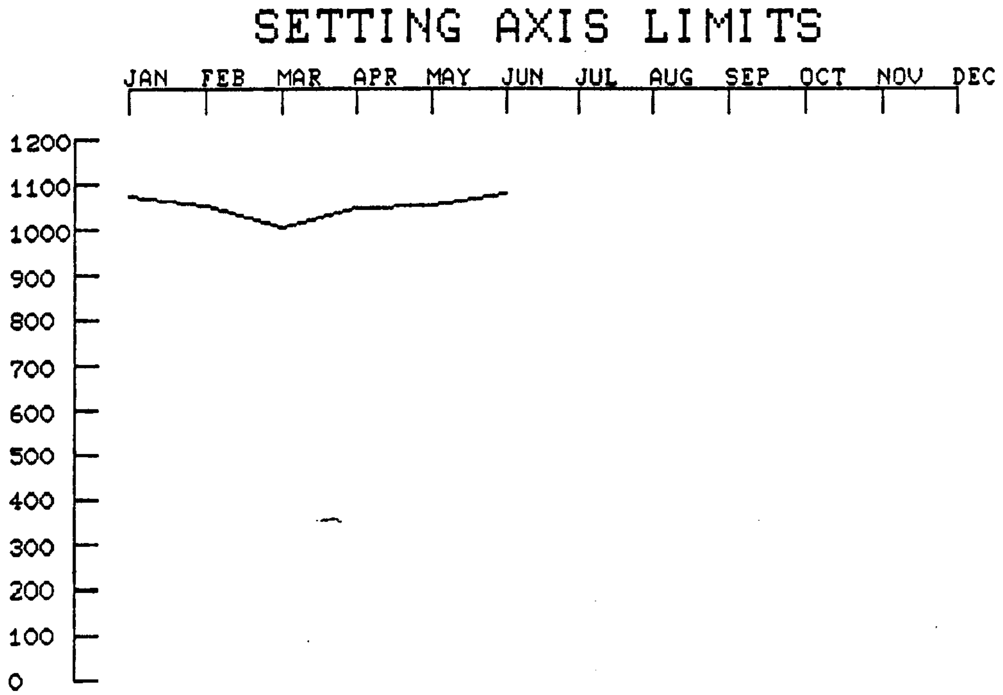
EXAMPLE 12: SCATTERGRAM

12.11 STYLE 'OBJECT'

You use the **'OBJECT'** plot style to draw a picture from a matrix of **x axis** and **y axis** coordinates, one row for each point. EXAMPLE 13 uses the 'OBJECT' plot style to draw an octagon.



EXAMPLE 13: OBJECT



EXAMPLE 14: SETTING AXIS LIMITS

13. SCALING THE PLOT (LIMS)

In the examples given so far, the **range** and **scale** of values represented by the **x axis** and the **y axis** was usually set automatically based on the argument to the **PLOT** function. By default, the range of the axes is from the lowest to the highest value for each axis. You can specify these limits explicitly by using the **LIMS** state setting function. The syntax of LIMS is:

```
     <axis> LIMS [ON|OFF|<range>]
     <axis> LIMS ''
<range>
```

where <axis> is one of 'X' or 'Y', and <range> is a vector of two numbers representing the low and high values to set for that axis.

Typically, you use the LIMS function to change the range and scale of the y axis. EXAMPLE 14 shows the use of both x axis and y axis limits. In that example, x axis limits are used to extend the range of the x axis to a full twelve months when only 6 months of data are plotted. Also, y axis limits are used to conform the y axis scale to the y axis **TIKS** and **LABEL** settings. Without setting y axis limits, the TIKS and LABELS would be inconsistent with the scale of the plot.

An important use of LIMS is to set the x axis **range** when you use **XCOL** ON to specify the x axis values explicitly. This use is demonstrated in EXAMPLE 12, a 'SCATTERGRAM' produced with XCOL ON.

14. USING SPECIAL EFFECTS (EFFECT)

You can use the **EFFECT** function to produce special effects such as **'DASH'** and **'HATCH'**. The EFFECT function also lets you enhance the plot with **'BLIND'** and **'SMOOTH'**. In addition, you use EFFECT to produce **multiple passes** and to specify **marker symbols (pictures)** at **plot points.**

The EFFECT function has the syntax

```
 <effect type> EFFECT [ON|OFF|<effect vector>]
 <effect type> EFFECT ''
<effect vector>
```

where <effect type> is one of:

'HATCH'

'DASH'

'PASS'

'SMOOTH'

'BLIND'

'PICS'

and <effect vector> is an appropriate vector of numbers representing an effect option, depending on the <effect type> being set.

The elements of <effect vector> apply to corresponding parts of the graph depending on the **plot style.** For **'LINEPLOT'** and **histograms**, each element of <effect vector> specifies the decoration or enhancement for a corresponding column of the **plot data.** For **'PIECHART'**, each element of <effect vector> affects a corresponding slice of the pie. With **'OBJECT'** plot style, each element of <effect vector> applies to a corresponding object as defined by the third column of plot data. The EFFECT settings are not applicable to **'HILOCLOSE'** plot style.

The EFFECT settings can be turned off and on. When you specify an <effect vector> parameter list for an <effect type>, that effect is automatically turned on. You can turn the effect off using the command

```
<effect type> EFFECT OFF
```

The <effect vector> parameter list for that <effect type> is retained when you use EFFECT OFF, but is ignored when the plot is drawn. You can turn the effect back on again with the last <effect vector> parameter list using the command

```
<effect type> EFFECT ON
```

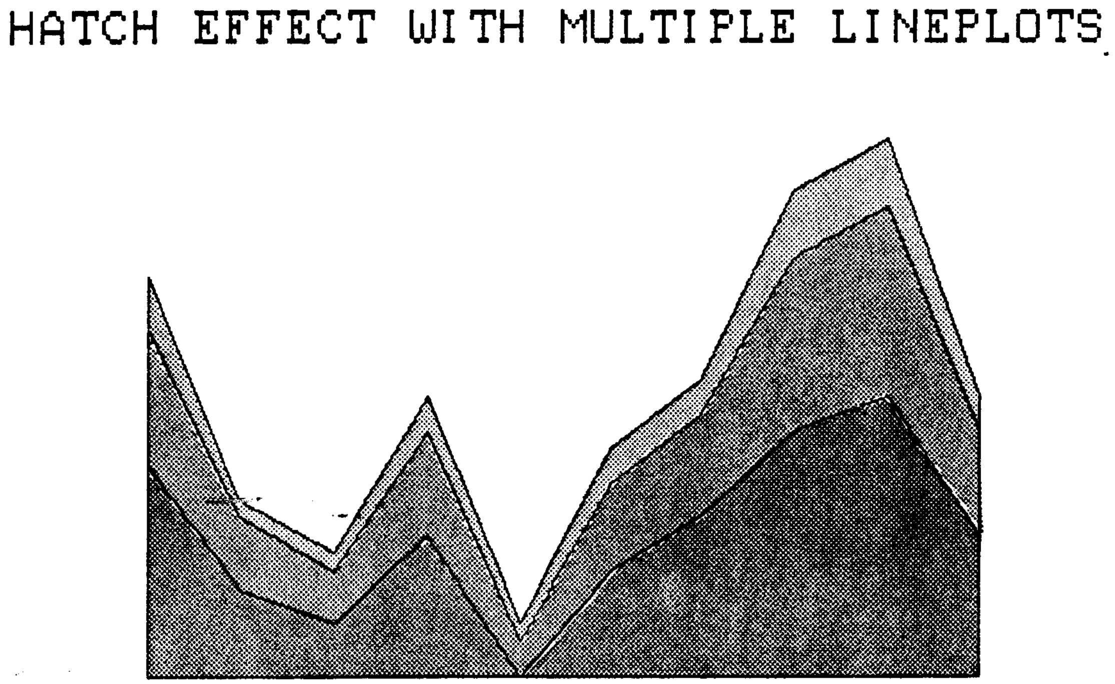
SUGGESTION: The EFFECT ON/OFF feature allows you to experiment with an effect, then temporarily turn the effect off without losing the <effect vector> parameter setting while you experiment with other FRESCO graphic commands. Since effects can slow down the drawing of the graph, the ON/OFF feature can speed up development.

14.1 'HATCH' EFFECT

```
'HATCH' EFFECT <hatch vector>
```

'HATCH' EFFECT fills an area of the **plot** with **shading** or **patterns.** Each number in <hatch vector> specifies the shading for a corresponding part of the plot.

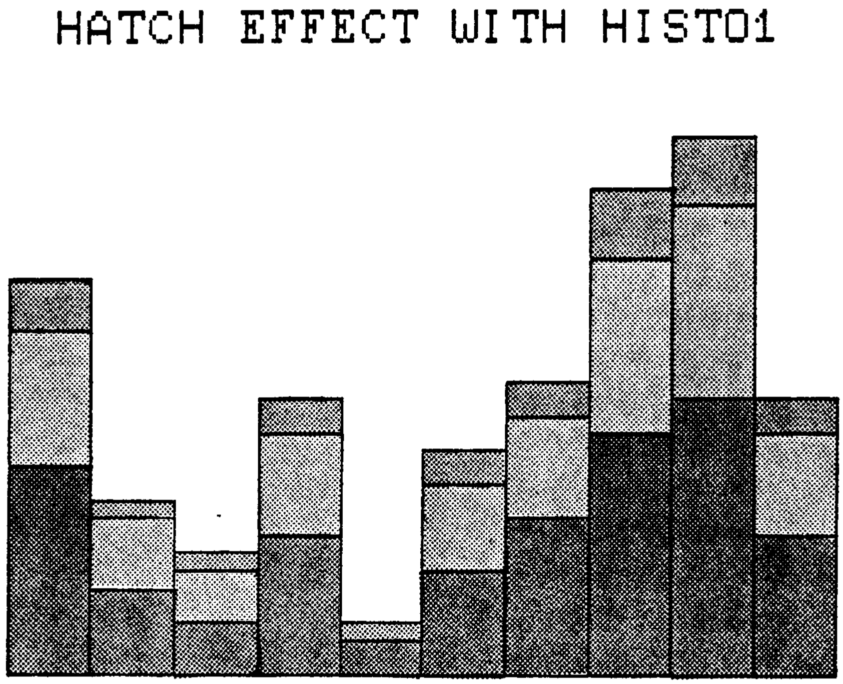
APPENDIX II lists the FRESCO hatch patterns. Specifying 0 as the pattern number turns off hatching for the corresponding element of the graph.



EXAMPLE 15: HATCH EFFECT WITH MULTIPLE LINEPLOTS

14.1.1 STYLE'LINEPLOT'

If only one plot is drawn with **'LINEPLOT'** plot style, 'HATCH' EFFECT fills the space from the plot to the bottom of the **AREA.** When drawing **multiple plots**, 'HATCH' EFFECT is only meaningful for **cumulative data**, and fills the space from the corresponding plot down to the next previous plot or to the bottom of the AREA. That is, the shading represents the contribution of that plot line to the total cumulative plot. This is shown in EXAMPLE 15.

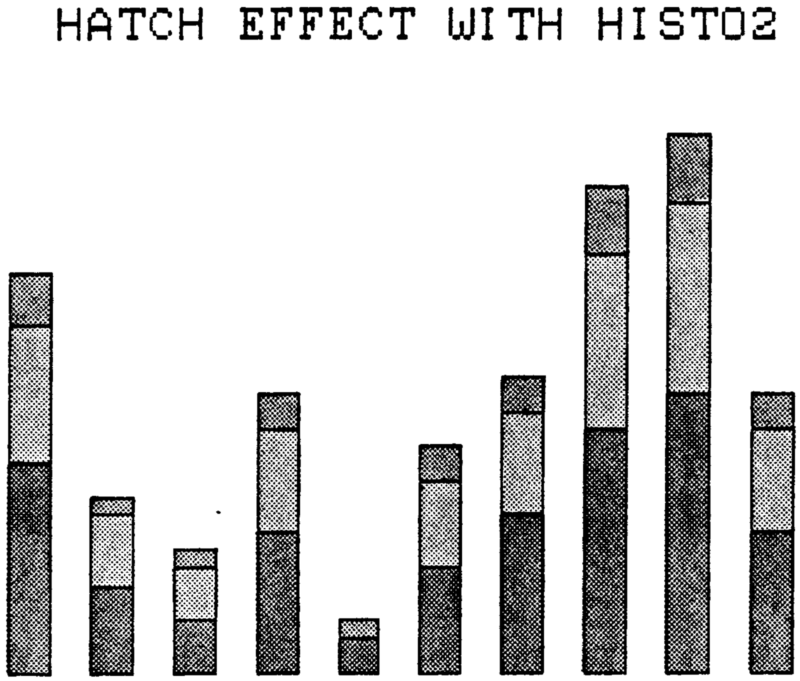


EXAMPLE 16: HATCH EFFECT WITH HISTO1

14.1.2 STYLE'HISTO1'

When drawing a single plot with plot style **'HISTO1'**, 'HATCH' EFFECT fills each rectangle with the first hatch pattern.

For **multiple plots** using 'HISTO1', 'HATCH' EFFECT is meaningful for **cumulative data**, and each element of <hatch vector> specifies the 'HATCH' pattern for a corresponding column of plot data. That is, as with style 'LINEPLOT', each pattern represents the contribution of a plot to the whole. EXAMPLE 16 shows a hatched cumulative 'HISTO1' barchart.



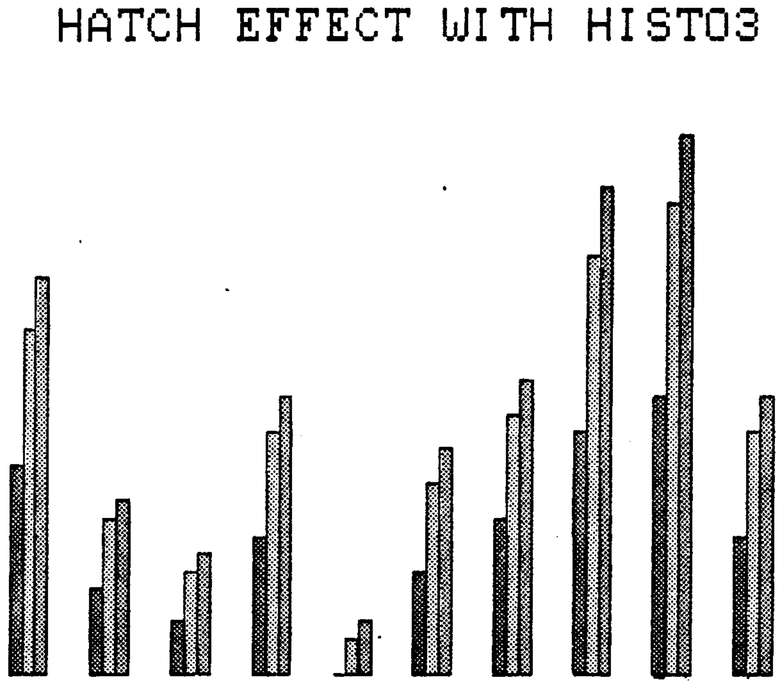
EXAMPLE 17: HATCH EFFECT WITH HISTO2

14.1.3 STYLE'HISTO2'

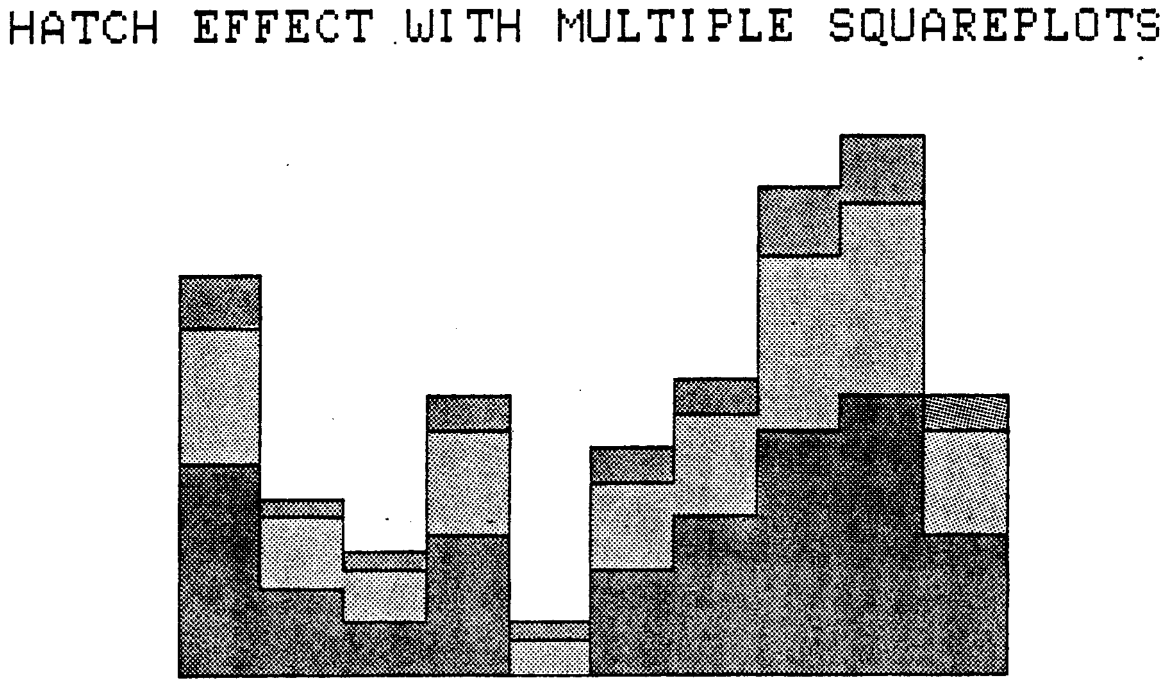
Same as 'HISTO1'; see EXAMPLE 17.

14.1.4 STYLE'HISTO3'

With line style **'HISTO3'**, each value of **multiple plots** is drawn as a separate bar side by side. The hatch patterns specified in <hatch vector> apply to each corresponding bar. This is shown in EXAMPLE 18.



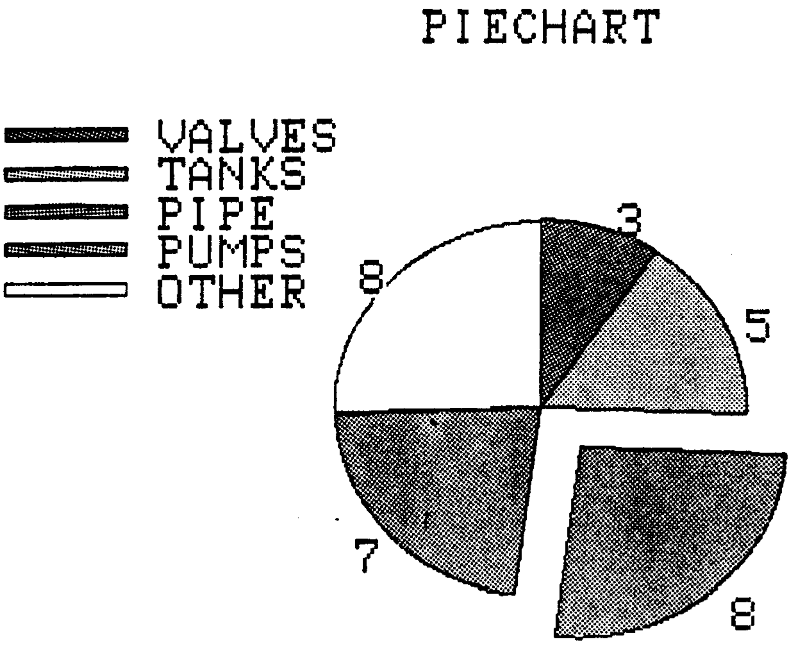
EXAMPLE 18: HATCH EFFECT WITH HISTO3



EXAMPLE 19: HATCH EFFECT WITH MULTIPLE SQUAREPLOTS

14.1.5 STYLE'SQUAREPLOT'

Same as 'LINEPLOT'; see EXAMPLE 19.



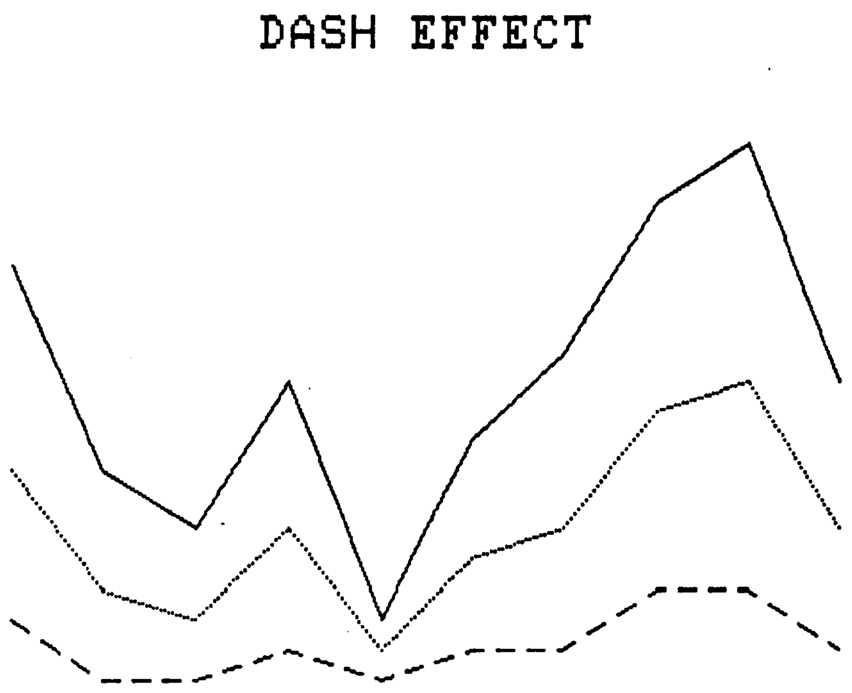
EXAMPLE 20: HATCH EFFECT WITH PIECHART

14.1.6 STYLE'PIECHART'

Each element of <hatch vector> specified for 'HATCH' EFFECT applies to a corresponding slice of the pie produced using plot style **'PIECHART'**. EXAMPLE 20 demonstrates HATCH EFFECT applied to a 'PIECHART'.

'HATCH' EFFECT is not applicable to styles **'HISTO4'** (histogram tops), **'HISTO5'** (vertical lines), or **'HILOCLOSE'**.

SUGGESTION: Because 'HATCH' EFFECT adds to the processing required to draw the plot, turn hatching off while experimenting with other features of the graph.



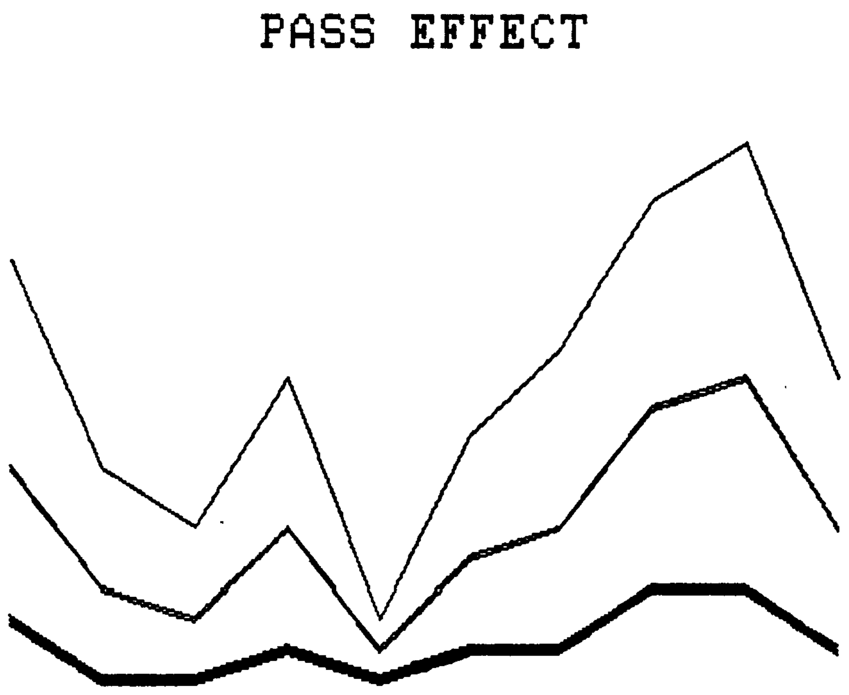
EXAMPLE 21: DASH EFFECT

14.2 'DASH' EFFECT

'DASH' EFFECT causes plot lines and the outline of histograms and 'PIECHART' to be drawn in patterns of dots or dashes. The syntax is

```
      'DASH' EFFECT [<dash vector>|ON|OFF]
      'DASH' EFFECT ''
<dash vector>
```

where <dash vector> is a numeric vector of dash styles. APPENDIX III contains a list of 'DASH' styles. 'DASH' EFFECT is useful for distinguishing **multiple plots** when using plot style **'LINEPLOT'**. EXAMPLE 21 shows how to plot three lines using a solid line for the first column of plot data, a dotted line for the second, and a dashed line for the third.



EXAMPLE 22: PASS EFFECT

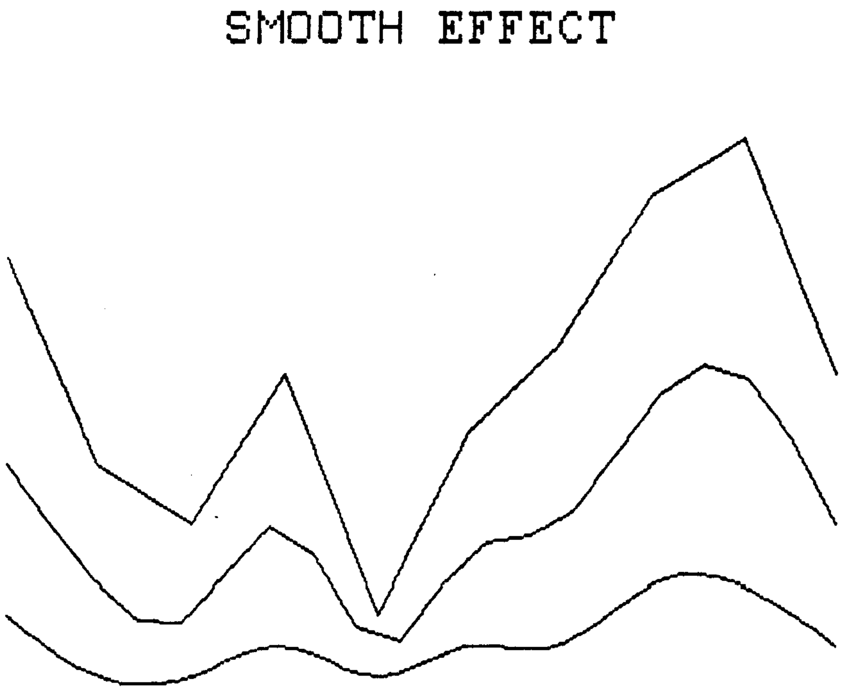
14.3 'PASS' EFFECT

```
 'PASS' EFFECT [<pass vector>|ON|OFF]
 'PASS' EFFECT ''
<pass vector>
```

'PASS' EFFECT allows you to thicken **plot lines** by specifying how many times the line is drawn. The <pass vector> argument is the number of passes made. A zero or one in <pass vector> indicates that no extra passes are made to the corresponding line; however, the line is still drawn once.

EXAMPLE 22 shows a multiple plot using plot style **'LINEPLOT'** with the second column drawn twice and the third line drawn three times.

'PASS' EFFECT is meaningful only with **'LINEPLOT'**, **'SQUAREPLOT'**, and **'HISTO4'** plot styles.



EXAMPLE 23: SMOOTH EFFECT

14.4 'SMOOTH' EFFECT

With **'LINEPLOT'** plot style, FRESCO ordinarily draws straight lines between each **plot point**. With **'SMOOTH' EFFECT**, additional points are computed and inserted between each pair of successive plot points specified in **plot data**. If sufficient smoothing points are inserted, the effect is to draw a **curve** which follows the trend of the points actually specified in **plot data**. This shows the data changing smoothly as a function of the **x axis values**, rather than abruptly at each plot point. The syntax is

```
     'SMOOTH' EFFECT [<smooth vector>|ON|OFF]
     'SMOOTH' EFFECT ''
<smooth vector>
```

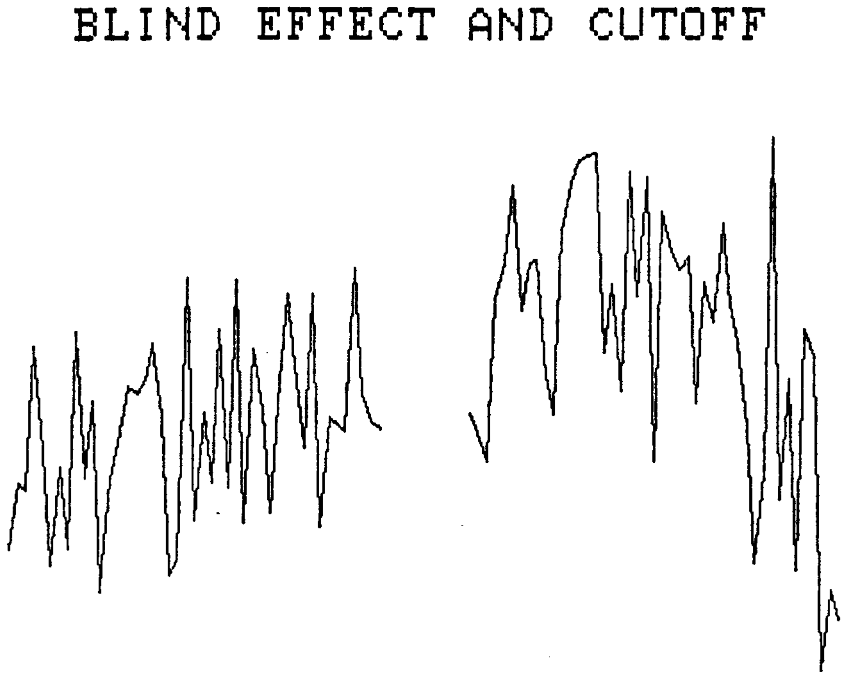
where <smooth vector> is the number of smoothing points to insert between adjacent plot points.

EXAMPLE 23 shows three plots of the same plot data, where the first plot is drawn unsmoothed, the second plot is smoothed by computing two smoothing points between each point in plot data, and the third plot is smoothed with the insertion of five additional points.

SUGGESTION: The number of additional points you need to specify between plot points in order to give a smooth curve effect depends on the distance between plot points and the variability of the values. When the plot data contains many plot points, you may need little or no smoothing to get a smooth curve. Likewise, if the plot data does not vary abruptly up and down from point to point, taking into account the scale of the plot, fewer smoothing points are needed to produce a smooth curve.. On the other hand, highly variable plot data may require a large number of smoothing points to produce a smooth curve. You may need to experiment with different numbers of smoothing points with different plots. In general, you will always get a smooth curve by specifying 10 smoothing points.

SUGGESTION: A substantial amount of processing is required for the program to calculate smoothing points. You can reduce the processing required to develop a plot by turning off smoothing while experimenting with other graph components.

'SMOOTH' EFFECT applies only to plot style **'LINEPLOT'**.



EXAMPLE 24: BLIND EFFECT AND CUTOFF

14.5 'BLIND' EFFECT AND CUTOFF

Sometimes **plot data** contain missing values represented as zero or some other special value. Simply removing these values from your plot data would skew the **x axis range** and misrepresent the data trend as a function of the x axis. It is usually better to keep the x axis uniform. On the other hand, it is wrong to draw a plot line to 0 or any other special value representing **missing data**. The missing data probably lies along the trend established by the available points. In such cases, it is more accurate to draw a discontinuity in the **plot line**.

If you need to represent missing data values as breaks with plot style **'LINEPLOT'**, or if you need to exclude extreme values using 'LINEPLOT' or **histograms**, you can use the **'BLIND' EFFECT** together with the **CUTOFF** state setting. The syntax is

```
      'BLIND' EFFECT [<blind vector>|ON|OFF]
      'BLIND' EFFECT ''
<blind vector>
```

where <blind vector> contains numeric codes interpreted according to the following list:

0	no data blinding is to take place.
1	blind points EQUAL to <blind value>.
2	blind points LESS THAN or EQUAL to <blind value>.
3	blind points GREATER THAN or EQUAL to <blind value>.
4	blind points LESS THAN <blind value>.
5	blind points GREATER THAN <blind value>.

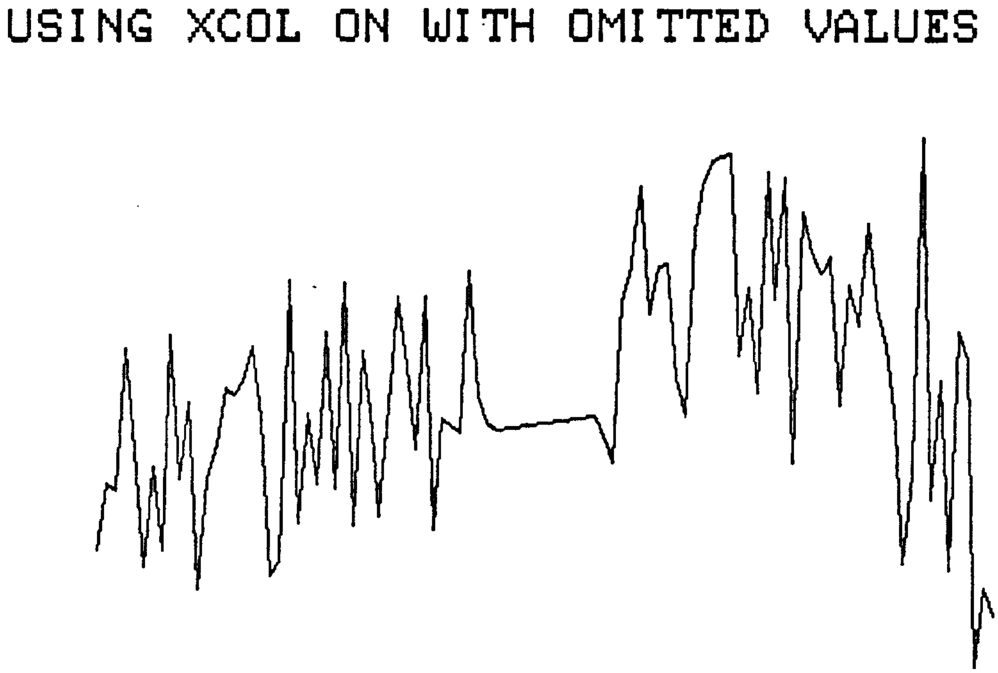
where <blind value> is the value specified using the CUTOFF state setting function. The syntax of CUTOFF is

```
      CUTOFF <blind value>
      CUTOFF ''
<blind value>
```

The default <blind value> is 0.

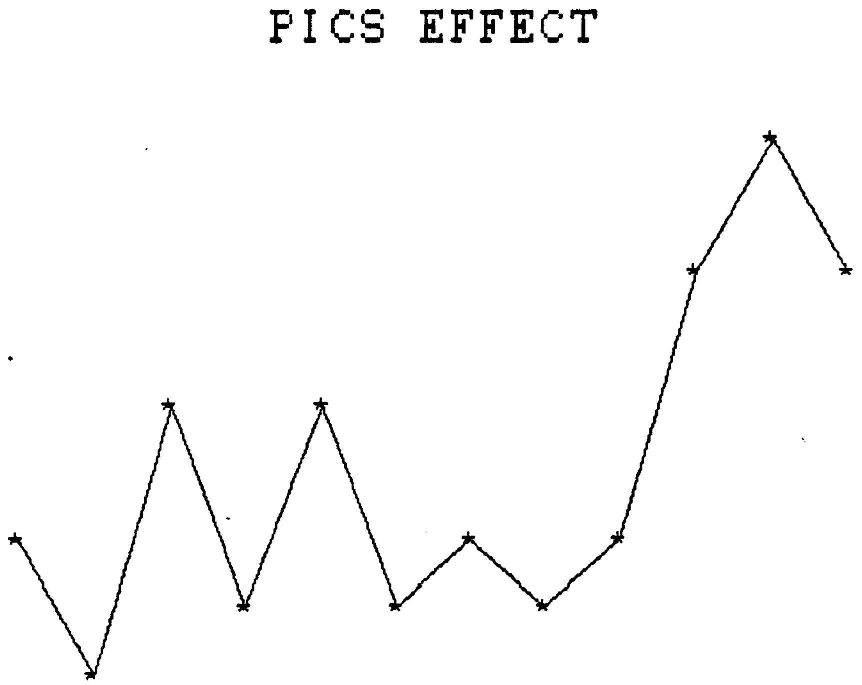
EXAMPLE 24 shows the use of 'BLIND' EFFECT and CUTOFF.

SUGGESTION: Another way to handle the problem of missing values without skewing the x axis is to use the **XCOL** feature. With XCOL ON, the first column of **plot data** is used as the **x axis values.** By omitting the x axis values corresponding to the missing **y axis values**, you can represent the graph as a continuous function without skewing. EXAMPLE 25 shows this approach.



EXAMPLE 25: XCOL ON WITH OMITTED VALUES

Blinding can be used in conjunction with '**SMOOTH**' and '**HATCH**', but is only meaningful with the '**LINEPLOT**' plot style.



EXAMPLE 26: PICS EFFECT

14.6 'PICS' EFFECT

'PICS' EFFECT draws **characters** at **plot points.** The syntax is

```
      'PICS' EFFECT [<pics vector>|ON|OFF]
      'PICS' EFFECT ''
<pics vector>
```

where <pics vector> is a numeric vector of **picture codes.** The <pics vector> parameter contains the numeric code of the **marker symbol** to use for each **plot line.** APPENDIX IV lists the picture codes and the corresponding symbol. Zero indicates that no marker symbol is to appear for that plot. See EXAMPLE 26.

15. SELECTING COLORS (PENS)

The **PENS** function selects **colors**. The syntax is

```
 [<default pen>] PENS <pen vector>
```

where <default pen> is the **pen number** for drawing **components of the graph** other than the **plot** (**borders**, **titles**, **ticks**, **labels**, etc.) and <pen vector> is a numeric vector of pen numbers for each plot, or, in the case of plot style **'PIECHART'**, for each **slice**.

The <default pen> argument may be omitted, in which case that parameter remains unchanged. Unlike the EFFECT function, the PENS function repeats the values of pen numbers if too few values are supplied.

The **default** state setting for PENS is

```
 1 PENS 1 2 3 4 5 6
```

16. LOCATING PLOT VALUES (TIKS)

The state setting function **TIKS** controls the placement of **tick marks** and associated **text**. Ticks show the location of certain values on the **x axis** or **y axis**, like the marks on a ruler. Labels identify the quantities associated with these locations, like the numbers on a ruler.

The syntax of the TIKS function is,

```
      <axis> TIKS [<tiks value>|ON|OFF]
      <axis> TIKS ''
<tiks value>
```

where <axis> is one of the following:

'XT'	horizontal rule above the plot (x axis top).
'XB'	horizontal rule below the plot (x axis bottom)
'X'	two horizontal rules, one above and below the plot.
'YL'	vertical rule to the left of the plot (y axis left).

'YR'	vertical rule to the right of the plot (y axis right).
'Y'	two vertical rules, one left and one right of the plot.

The right argument <tiks value> may be a scalar, vector, or matrix. A scalar value for <tiks value> represents the number of ticks to draw equally spaced along the axis. A vector value for <tiks value> represents the **plot values** where ticks will be drawn. A matrix value for <tiks value> must have two columns. The first column represents plot values (as with a vector argument), and the second column represents the relative length of the corresponding tick as a fraction or multiple of **'A' SIZE** (usually a value between 0 and 1).

For example,

```
'X' TIKS 6
```

six equidistant x axis ticks both above and below the graph.

```
'Y' TIKS 20
```

20 equidistant y axis ticks both to the left and to the right of the graph.

```
'XB' TIKS 3 6 9
```

three x axis ticks at the bottom of the graph at x axis values 3, 6, and 9.

```
'XB' TIKS 3 6 9 ,[1.5] 1 1 1
```

three x axis ticks at the bottom of the graph at x axis values 3, 6, and 9.

```
'XT' TIKS 3 6 9 ,[1.5] 1 0.5 1
```

three x axis ticks at the top of the graph at x axis values 3, 6, and 9, but with the middle tick half as long as the other two.

```
'Y' TIKS 0 1000
```

two y axis ticks both to the left and to the right of the graph at y axis values 0 and 1000.

```
'YL' TIKS 5
```

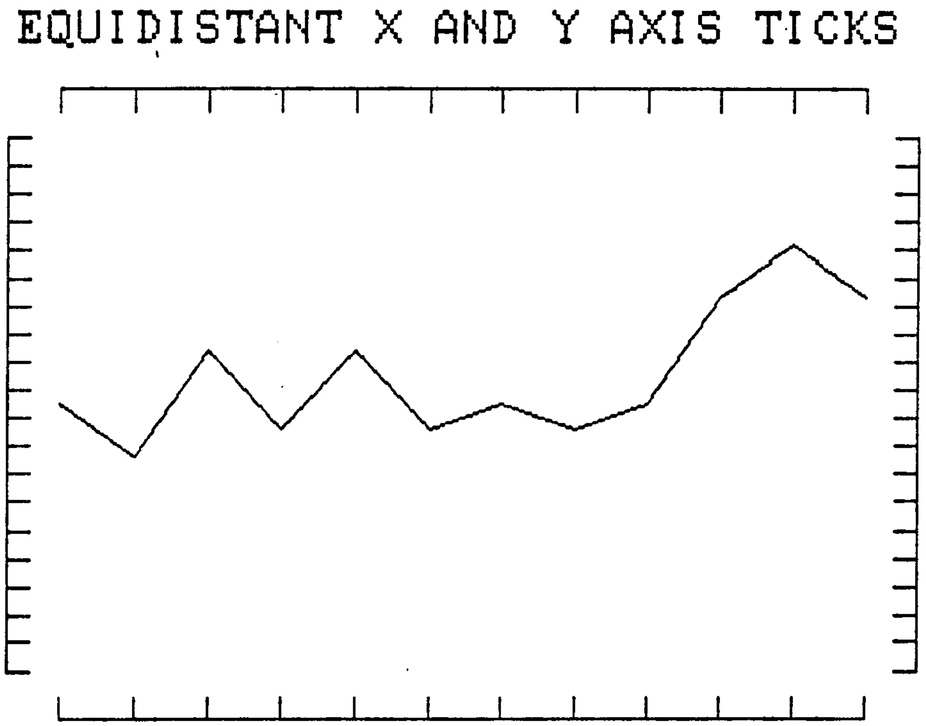
five equidistant y axis ticks to the left of the graph.

```
'X' TIKS OFF
```

no x axis ticks.

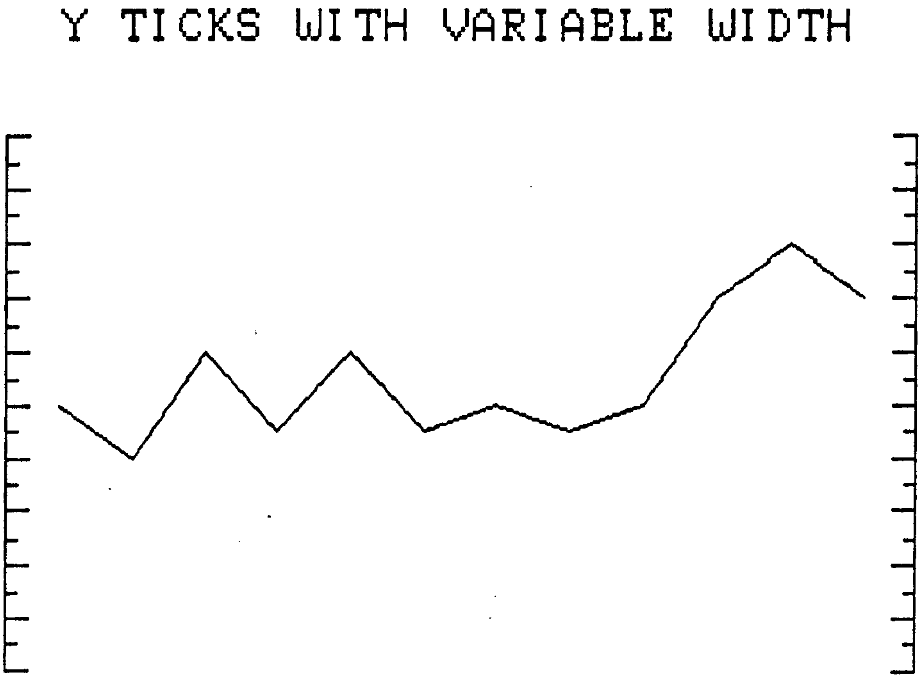
```
'Y' TIKS OFF
```

no y axis ticks.



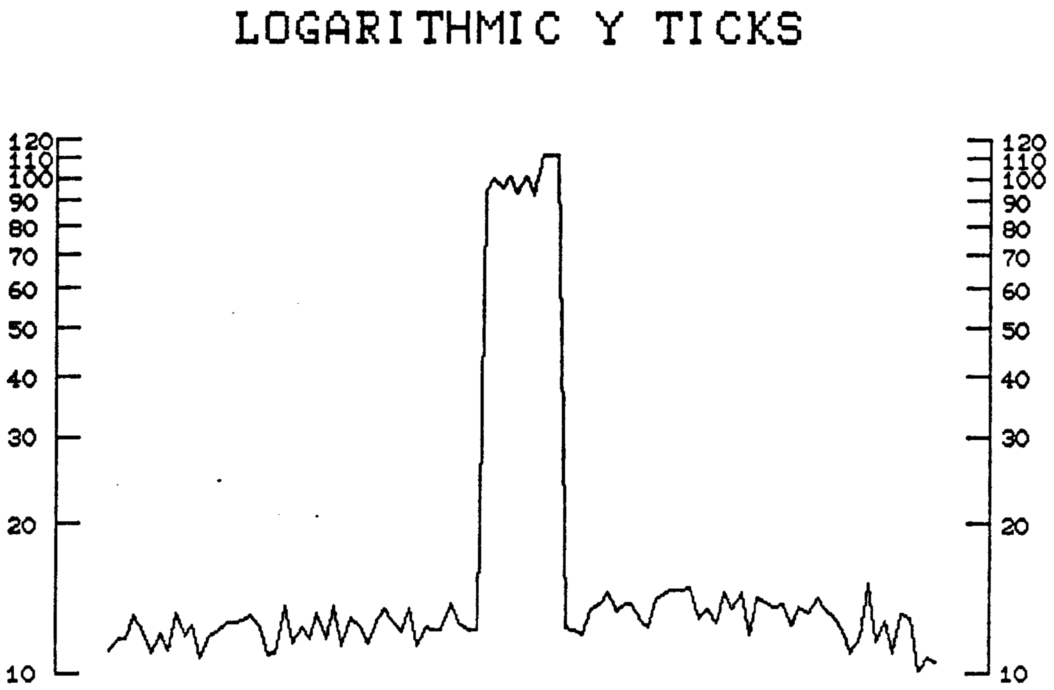
EXAMPLE 27: EQUIDISTANT X AND Y AXIS TICKS

EXAMPLE 27 shows the effect of using the TIKS function with a scalar value to give a certain number of equidistant ticks.



EXAMPLE 28: Y TICKS WITH VARIABLE WIDTH

EXAMPLE 28 shows how the matrix argument allows you to vary the length of ticks.



EXAMPLE 29: LOGARITHMIC Y TICKS

The graph in EXAMPLE 29 shows the placement of ticks at specific locations along the axis.

SUGGESTION: To center x axis ticks in the bars when using **histograms**, add one extra tick when specifying by number of ticks, or add .5 when specifying by value.

17. SPECIFYING AXIS LABELS (LABEL)

The **LABEL** function allows the placement of **text** at **tick marks**. In addition, you use the LABEL function to insert text at **plot points**, including histogram tops and **'PIECHART'** slices. The syntax is

```
      ['P'|<axis>] LABEL [<text>|ON|OFF]
      ['P'|<axis>] LABEL ''
<text>
```

where <axis> is an **axis specifier 'XT'**, **'XB'**, **'X'**, **'YL'**, **'YR'**, or **'Y'**, and <text> is a **text specifier** in which the labels correspond to ticks set using the **TIKS** function. The **'P'** argument allows you to specify text for **plot points.**

For example,

```
'X' LABEL 1 2 3 4 5 6 7 8 9 10
```

labels 1 through 10 print both above and below the plot.

```
'YR' LABEL '/CAT/RAT/FAT'
```

labels CAT, RAT, and FAT print to the right of the plot at the first three y axis ticks.

Excess labels are ignored if more labels are supplied than there are tick points. If too few labels are supplied, nothing is printed at ticks that do not have corresponding text. Blanks can be inserted into either character segmented strings or matrices to suppress text at certain points, for example,

```
'YR' LABEL '/CAT//RAT//FAT'
```

skips one tick between CAT and RAT, and also between RAT and FAT.

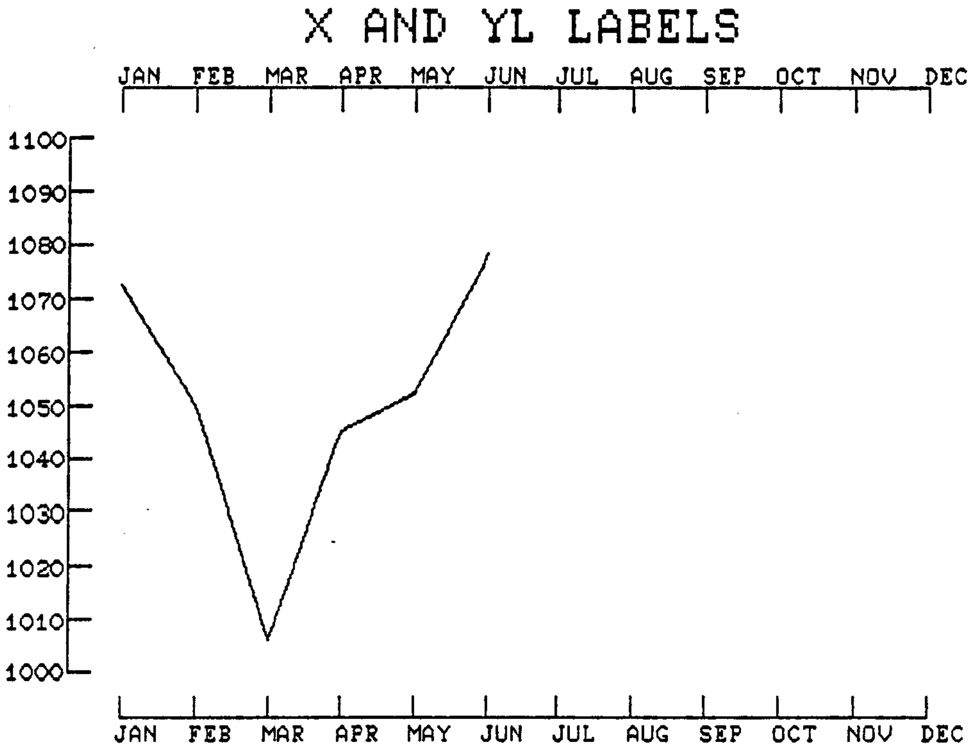
Text for the LABEL function may be suppressed or reinstated by using the **OFF** and **ON** functions. For example, if y axis labels have been specified,

```
'Y' LABEL OFF
```

suppresses the y axis labels, and

```
'Y' LABEL ON
```

reinstates them.



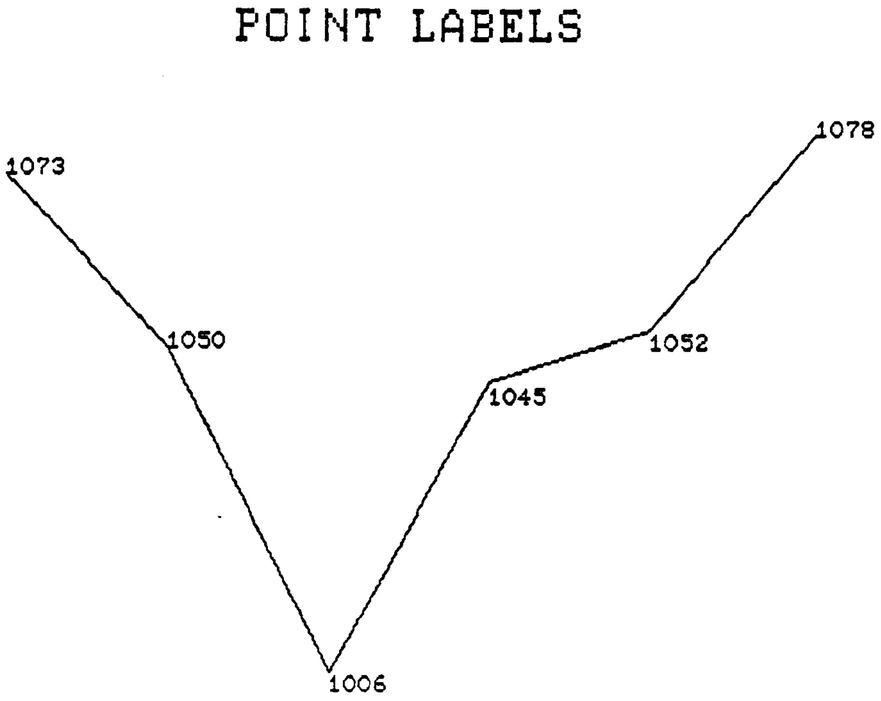
EXAMPLE 30: X AND YL LABELS

EXAMPLE 30 shows labels specified using a vector of numbers for the y axis and a character matrix for the x axis. EXAMPLE 29 shows y axis labels that have been computed to match the logarithmic scale of the **plot data**.

The LABEL function is also used to annotate **plot points**, **histograms**, and **'PIECHART'** slices by using the **'P'** left argument. These labels are printed in the same **color** as the corresponding line. For example,

```
'P' LABEL 5 20 17 32 11
```

draws each number in the right argument at a corresponding point, histogram, or pie slice.



EXAMPLE 31: POINT LABELS

EXAMPLE 31 shows **point labels** on a **'LINEPLOT'**, and EXAMPLE 20 shows point labels on a 'PIECHART'.

If you supply fewer point labels than plot points, the remaining plot points are unlabelled. If you supply too many point labels, the extra labels are ignored. Be sure to supply enough point labels for all points in **multiple plots**. With multiple plots, the point labels are applied to all of the points in the first plot, then to points in the second plot, and so forth.

18. SPECIFYING TITLES AND FOOTNOTES (TITLE)

The **TITLE** function allows you to draw several kinds of **titles** and **footnotes**. You can draw a main title centered at the top of the graph. Titles can be specified for each **axis** and for the **legend**. Also, you can place footnotes in any of the four corners of the graph. The syntax of the TITLE function is,

```
      ['T'|'L'|<axis>|<corner>] TITLE <text>
      ['T'|'L'|<axis>|<corner>] TITLE ''
<text>
```

where <axis> is an **axis specifier** **'XT'**, **'XB'**, **'X'**, **'YL'**, **'YR'**, or **'Y'**, and <corner> is one of the following:

'UL'	upper left corner.
'UR'	upper right corner.
'LL'	lower left corner.
'LR'	lower right corner.

The right argument <text> is a **text specifier** consisting of a numeric vector, delimited character vector, character matrix, or vector of nested character vectors. Each **text line** is interpreted as a separate line of the title. The **'T'** left argument specifies the **top title** and the **'L'** left argument specifies the **legend title.** Here are some examples:

```
'T' TITLE '/ACME SALES/1990'
```

specify the top title in two lines.

```
'XB' TITLE '/MONTH'
```

identify the x axis at the bottom as MONTH.

```
'Y' TITLE '/MILLIONS OF DOLLARS'
```

identify the y axis as MILLIONS OF DOLLARS with identical text on both the left and right side of the plot.

```
'L' TITLE '/PRODUCT'
```

place a title above the legend identifying each plot as a different PRODUCT.

```
'UL' TITLE '/PREPARED BY WWW'
```

place a footnote at the upper left corner.

```
'LR' TITLE '/NOVEMBER 11, 1989'
```

place a footnote at the lower right corner.

Any title which has been specified using the TITLE function can be turned off independently using the **OFF** argument, then reinstated to its pre-existing specification using the **ON** argument. For example,

```
'LL' TITLE '/PRO FORMA'
```

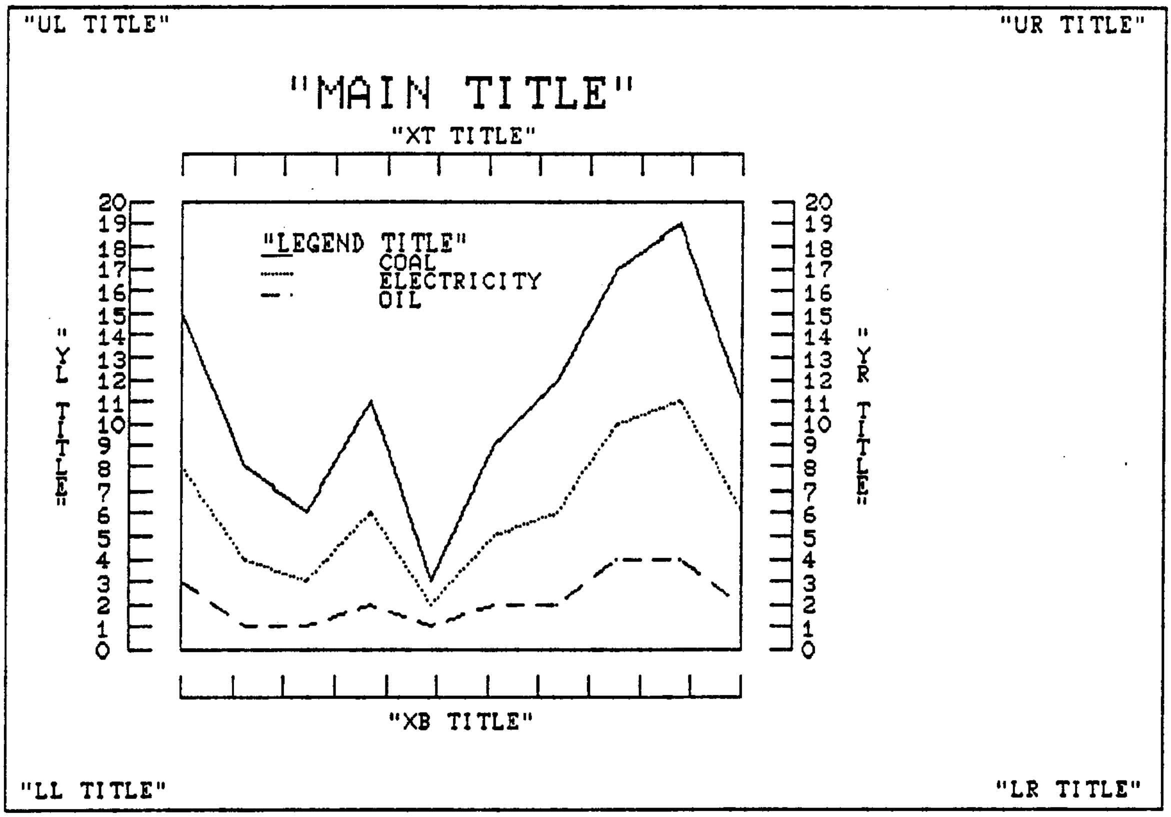
specify PRO FORMA as the lower left footnote.

```
'LL' TITLE OFF
```

suppress the lower left footnote.

```
'LL' TITLE ON
```

reinstate the lower left footnote as PRO FORMA.



EXAMPLE 32: TITLES AND FOOTNOTES

EXAMPLE 32 shows the placement of various titles. Notice that the **footnote** titles are placed relative to the **PAGE**, but that the other titles are placed relative to the **AREA**.

19. USING LEGENDS TO IDENTIFY MULTIPLE PLOTS (LEGEND)

When you specify a **LEGEND** for the graph, a sample of each **plot graphic** is drawn. This lets you describe the meaning of each **plot** by specifying a **legend label** for each plot graphic.

You use the LEGEND function to turn on or off the drawing of legend graphics. The syntax is,

```
      LEGEND [ON|OFF]
      LEGEND ''
[1|0]
```

```
      LEGEND ON
```

a legend is drawn.

```
      LEGEND OFF
```

a legend is not drawn.

Use the **TITLE** function with the left argument **'L'** to specify a title for the legend, and use the **LABEL** function with left argument **'L'** to specify a label for each legend line. For example,

```
      'L' LABEL 1978 1979 1980
```

1978, 1979, and 1980 will be shown next to each corresponding legend graphic in the legend.

Legend labels are drawn in the same **PENS**, **'DASH'** pattern, **'PICS'** picture, or **'HATCH'** pattern as the corresponding **plot**. FRESCO selects the appropriate **legend graphic** for the **plot style** at hand. For example, a **'LINEPLOT'** produces a line as the legend graphic, whereas **histograms** produce a box. Legends are drawn left justified.

EXAMPLE 38 contains a legend to identify the plots in **multiple plots**, a histogram, and EXAMPLE 20 shows a **'PIECHART'** legend.

20. ADJUSTING THE LOCATION OF TEXT (DIST)

The **DIST** function adjusts the **location** of **text** by specifying a **distance** relative to the **AREA**. The syntax is,

```
    ['T'|'A'|'L'|<axis>] DIST <distance>
    ['T'|'A'|'L'|<axis>] DIST ''
<distance>
```

where <axis> is an **axis specifier** (one of **'XT'**, **'XB'**, **'X'**, **'YL'**, **'YR'**, **'Y'**), and <distance> is a numeric scalar or two element vector representing length in inches. The various left arguments have the following meanings:

'T'	sets the distance of the top title from the top of the AREA.
'A'	sets the distance the ticks are moved outward from the **AREA**.
'L'	sets the distance the legend is located from the upper left corner of the AREA.
<axis>	sets the distance axis titles are located outward from the AREA.

Here are a few examples:

```
'T' DIST .25
```

the top of the first line of the top title is located .25 inches from the top of the AREA.

```
'X' DIST .5
```

the x axis titles are moved out .5 inches from the top and bottom of the AREA.

```
'YL' DIST .1
```

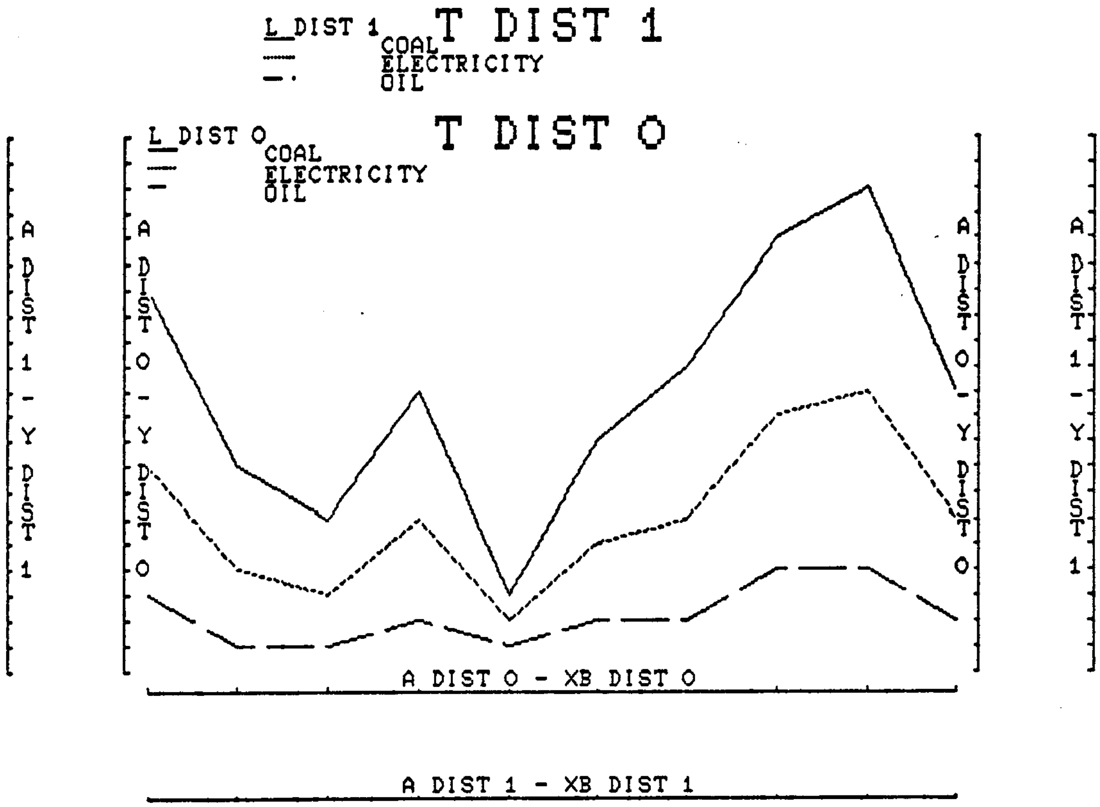
the left y axis title moves left .1 inch from the left side of the AREA.

```
'A' DIST .3
```

ticks are moved out .3 inch from the AREA.

```
'L' DIST 2 2.5
```

the first line of the legend is located two inches to the right and 2.5 inches down from the upper left corner of the graph.



EXAMPLE 33: EFFECT OF DIST SETTINGS

EXAMPLE 33 shows how the various text components move relative to the **AREA** depending on the DIST settings.

21. ADJUSTING THE SIZE OF TEXT (SIZE)

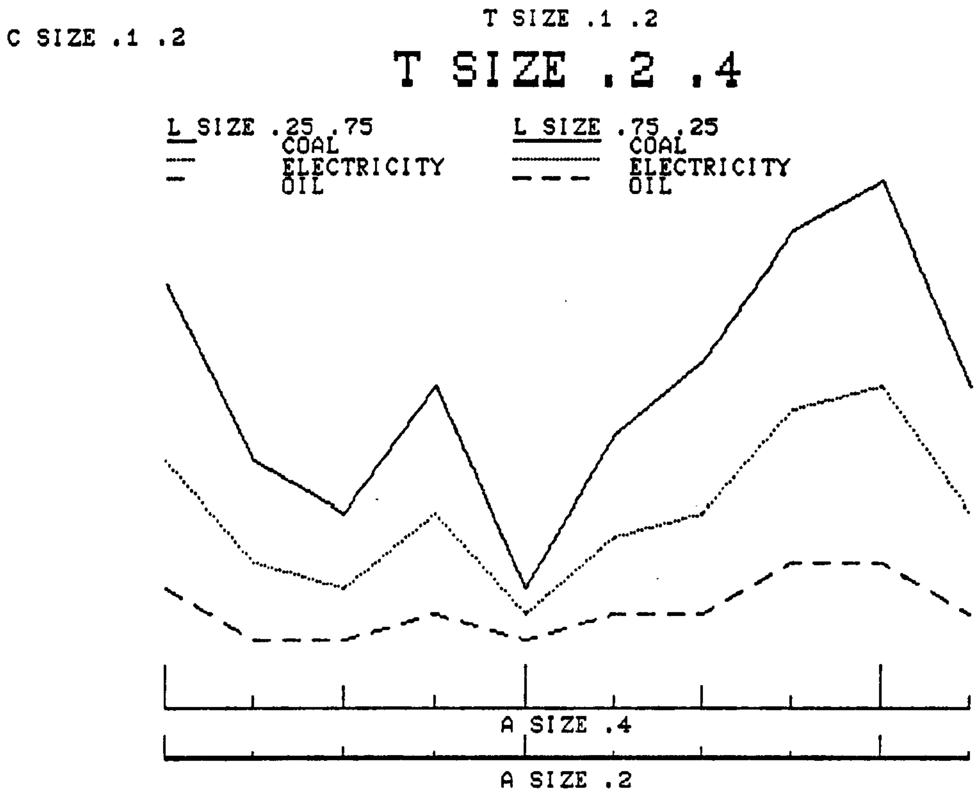
The **SIZE** function controls the size of **text**, **LEGEND** format, and **TIKS** length. The syntax is,

```
['T'|'C'|'A'|'L'] SIZE <size>
['T'|'C'|'A'|'L'] SIZE ''
```

<size>

where <size> is a numeric scalar or two element vector representing size in inches. The four left arguments give the following results:

'T' SIZE x,y	width and height of characters appearing in the **top title.**
'C' SIZE x,y	width and height of all other text appearing in the graph.
'A' SIZE d	length of ticks.
'L' SIZE d1,d2	length of legend graphic (d1) and distance text begins from the end of the graphic (d2).



EXAMPLE 34: EFFECT OF SIZE SETTINGS

EXAMPLE 34 shows the effects of various SIZE settings.

22. USING THE 'PIECHART' PLOT STYLE

When using the **'PIECHART'** plot style, state settings are given special meanings useful for that type of plot, some state settings are ignored, and some state settings peculiar to 'PIECHART' are available. In addition, a special form of **plot data** is required.

With 'PIECHART' plot style, only one plot is possible with one use of the **PLOT** function. The plot data is a vector, or a one or two column matrix. The vector, or first column if plot data is a matrix, contains the **plot values.** Each value determines the proportional share of the pie drawn for a corresponding pie slice.

If the argument is a matrix, the optional second column contains the distance in inches to move the corresponding pie slice out from the center of the pie (an exploded pie).

Multiple values set using the **PENS** and **EFFECT** state settings apply to corresponding pie sections. State setting functions pertaining to axes, such as **LIMS**, **axis titles**, and **TIKS**, have no effect on 'PIECHART'.

The 'PIECHART' plot style starts drawing pie slices from the top of the pie, proceeding clockwise for each corresponding value in **plot data**.

The **SIZE** function allows you to set the diameter of a pie chart.

```
'P' SIZE 4
```

piechart diameter of 4 inches.

The **LABEL** function allows you to label 'PIECHART' slices. 'PIECHART' labels are always drawn horizontally. Each item in the LABEL argument labels a corresponding 'PIECHART' slice. For example,

```
'P' LABEL '/US/GB/FRG/FR/CAN/JAP'
```

EXAMPLE 20 shows a typical pie chart.

23. TURNING OFF HATCH STACKING (STACK)

When drawing **multiple plots** with plot styles **'LINEPLOT'**, **'HISTO1'**, **'HISTO2'**, or **'SQUAREPLOT'**, you ordinarily plot **cumulative data**, meaning that each plot represents the cumulative value after adding an incremental part. That way, each successive plot is drawn above the previous one (they do not cross). To facilitate this approach, **'HATCH' EFFECT is stacked**; that is, 'HATCH' for one line extends from that line to the line below it.

When hatching multiple plots that are not cumulative (the lines may cross), you should turn off stacking using the STACK function.

```
STACK ON
```

default hatching stacking.

```
STACK OFF
```

hatching hatches to zero for all lines.

24. CONTROLLING THE WIDTH OF HISTOGRAM BARS (RATIO)

The **RATIO** function is used to select the width of **'HISTO2'**, **'HISTO3'**, **'HISTO4'** and **'HILOCLOSE'** line styles. An acceptable argument is a number between 0 and 1 where 1 would cause a full width bar to be drawn.

```
RATIO 0.5
```

bar is half the width of the space between bars.

25. 'OBJECT' PLOTTING

'OBJECT' plotting, invoked with STYLE 'OBJECT', allows you to supply FRESCO one or more APL matrices containing x,y cartesian pairs. You use the OBJECT plot style for drawing arbitrary shapes, such as maps, or for adding special effects to plots produced with other plot styles. All applicable state setting functions, such as **'HATCH' EFFECT**, **'DASH' EFFECT**, **'P' LABEL**, **'T' TITLE**, and **PENS**, are observed. Like other FRESCO plot styles, 'X' and 'Y' **LIMS** are observed and the resulting image is drawn in the space defined by **AREA**.

The **plot data** is either a two or three column matrix in which the columns have the following meanings:

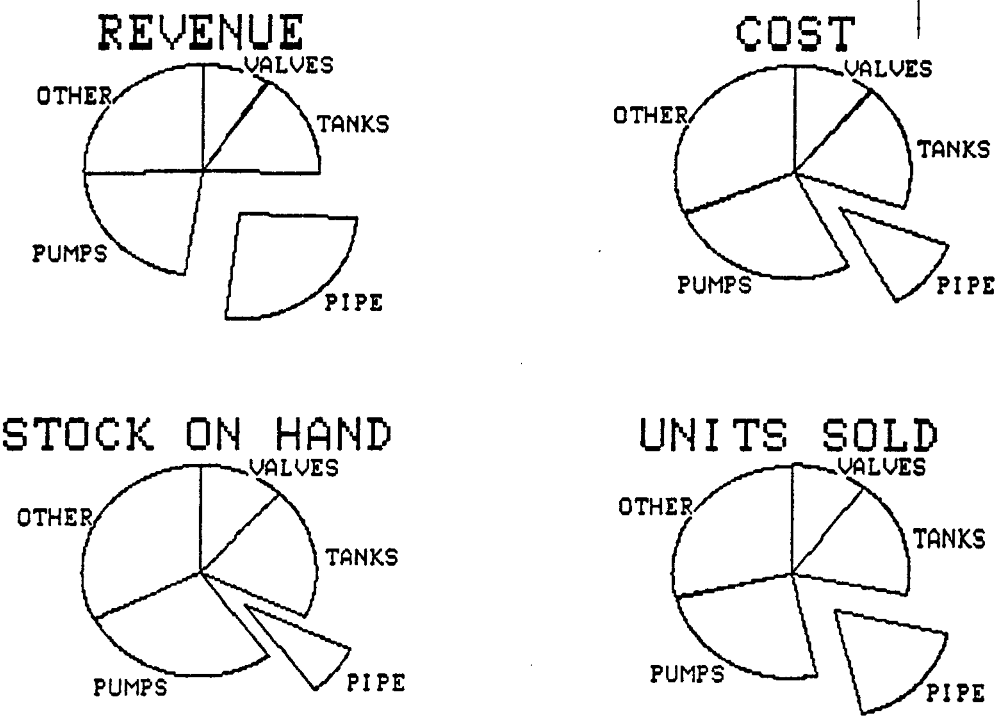
OBJECT[;1]	x coordinate.
OBJECT[;2]	y coordinate.
OBJECT[;3]	(optional) object delimiter and pen controls.

Optional column 3 may have the following values:

1	object delimiter.
0	move to this point with pen raised.
1	draw to this point with pen lowered.

The PLOT argument may be a single graphic object, or two or more graphic objects catenated together along the first coordinate. If a two column matrix is supplied, pen controls are assumed to be 1 for all points. If a three column matrix is supplied, OBJECT[1;3] is assumed to be 1. The first element in the third column of every individual graphic object must be 1 prior to being catenated together. The object delimiters serve to separate graphic objects catenated together on the first coordinate. When several graphic objects are supplied to PLOT, FRESCO state setting functions such as **PENS**, **'HATCH' EFFECT**, and **'DASH' EFFECT** apply to individual graphic objects on an itemwise basis.

When 'P' LABEL is used in conjunction with STYLE 'OBJECT', point labels correspond to graphic object points on an itemwise basis.



EXAMPLE 35: USING SPLIT TO DRAW MULTIPLE PIECHARTS ON ONE PAGE

26. SPLITTING UP THE GRAPH (SPLIT, DIVIDER)

The **SPLIT** function allows you to subdivide the **PAGE** so that a number of smaller plots may be produced on one page, as in EXAMPLE 35. The syntax is,

```
      <axis> SPLIT <ratio>
      <axis> SPLIT ''
<ratio>
```

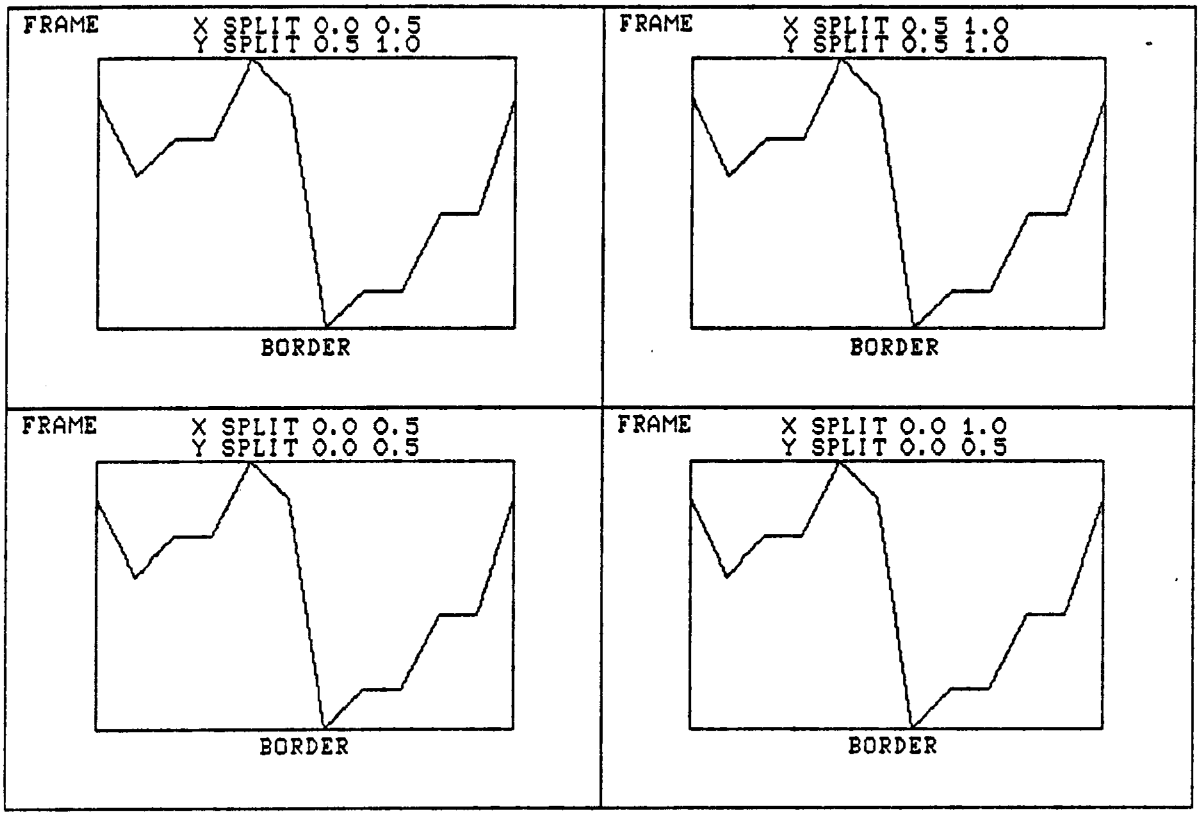
For example, to select the upper right hand quarter of the current PAGE setting,

```
      'X' SPLIT 0.5 1
```

select the right half on the x axis.

```
      'Y' SPLIT 0.5 1
```

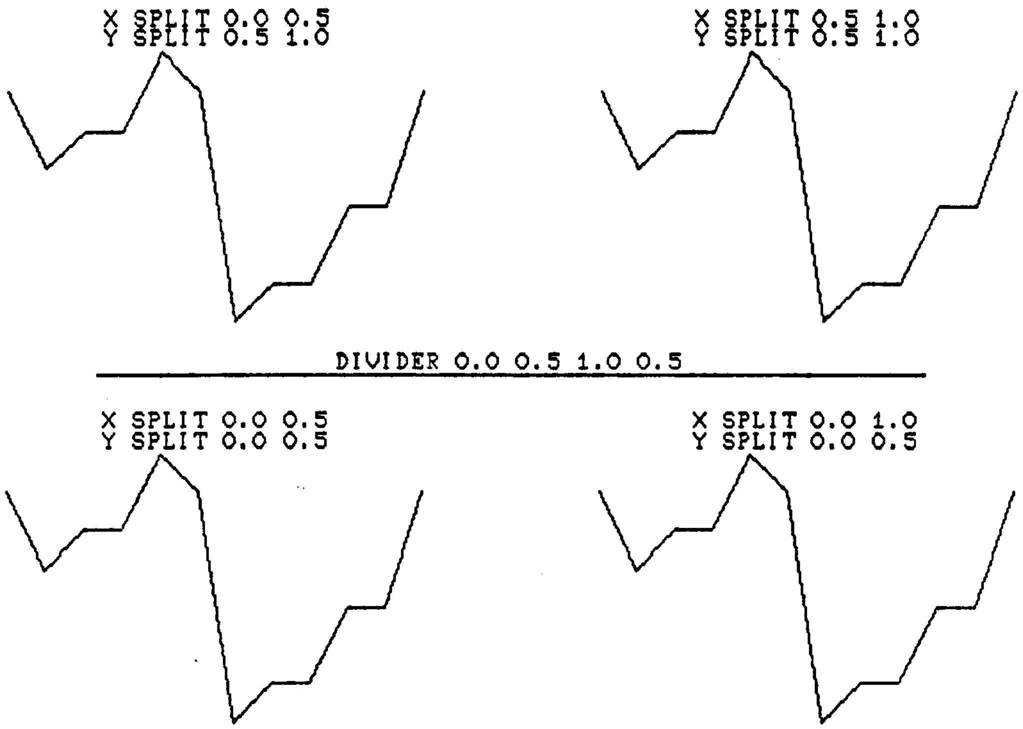
select the upper half on the y axis.



EXAMPLE 36: PAGE AND AREA WHEN USING SPLIT

The SPLIT function allows you to select a fraction of the existing PAGE on both the x axis and y axis. The effective PAGE is the intersection of the selected splits, as shown in EXAMPLE 36.

All elements which center around the PAGE center around the subdivision created by the SPLIT. You should reduce **text SIZE** and **TIKS** lengths to suit the smaller plot size.



EXAMPLE 37: USING DIVIDER WITH SPLIT

The **DIVIDER** function allows you to draw dividing lines around SPLIT plots, as shown in EXAMPLE 37. Its argument is a four element numeric vector representing the normalized x,y coordinates for the corners of a rectangle. The syntax is,

```
      DIVIDER <x1, y1, x2, y2>
      DIVIDER ''
<x1, y1, x2 y2>
```

where <x1, y1, x2, y2> are coordinates expressed as a ratio between 0 and 1 of the device coordinates. For example,

```
      DIVIDER 0 .5 1 1
```

draw a box around the upper half of the device.

When the corners have the same vertical or horizontal value, the result is to draw a line rather than a rectangle. For example,

```
DIVIDER 0 0.5 1 0.5
```

horizontal line through the middle of the device.

```
DIVIDER 0.5 0 0.5 1
```

vertical line through the middle of the device.

27. USING EXPLICIT X VALUES (XCOL)

The XCOL function indicates that the first column in plot data contains values to be used as the plot abscissa (x values); the other columns remain the ordinate (y values) for the plot, and are plotted as dependent variables.

```
XCOL ON
```

The first data column is to be the abscissa.

```
XCOL OFF
```

The first data column is the first line to be drawn. The abscissa is implicitly given by the number of data points.

See EXAMPLE 12, a 'SCATTERGRAM', and EXAMPLE 25 for sample graphs produced with XCOL ON.

28. DRAWING A BORDER OR FRAME

The **BORDER** and **FRAME** state setting functions draw rectangles around the graph. The BORDER setting draws a box around the AREA. The FRAME setting draws a box around the graph. The syntax is,

```
      BORDER [ON|OFF]
      BORDER''
[0|1]

      FRAME [ON|OFF]
      FRAME''
[0|1]
```

See EXAMPLE 1 and EXAMPLE 36 for samples of graphs produced using the BORDER and FRAME settings.

29. DRAWING A LINE AT Y VALUE 0 (BASE)

The BASE function draws a horizontal line in the plot where the y axis value is zero. The syntax is,

```
      BASE [ON|OFF]
      BASE''
[0|1]
```

30. ROTATING LABELS (ROTATE)

Point labels and x axis labels may be rotated for aesthetic reasons or to avoid collisions with other labels or lines. The syntax is,

```
      ['P'|'X'] ROTATE <degrees>
      ['P'|'X'] ROTATE ''
<degrees>
```

For example,

```
      'P' ROTATE 45
```

rotate point labels 45 degrees upward.

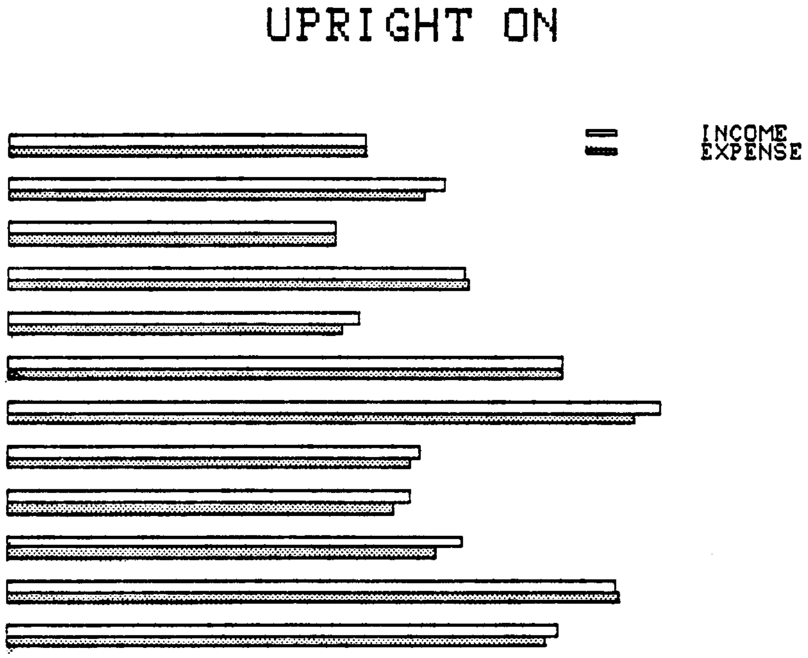
```
      'X' ROTATE 315
```

rotate x axis labels 45 degrees downward.

31. EXCHANGING PLOT AXES (UPRIGHT)

The UPRIGHT function causes the plot to be drawn rotated 90 degrees inside the AREA. The x axis and y axis change places and associated ticks, labels, and titles change places along with the axes, as shown in EXAMPLE 45. The syntax is,

```
      UPRIGHT [ON|OFF]
      UPRIGHT ''
[0|1]
```

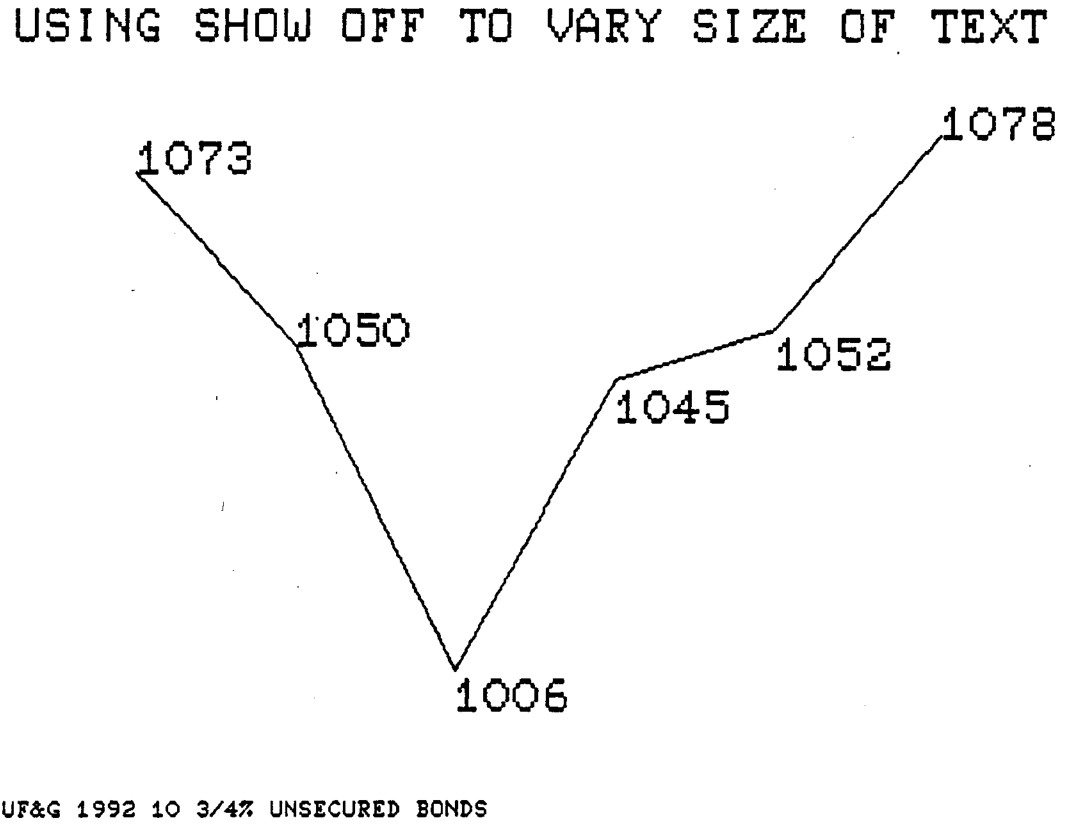


EXAMPLE 38: UPRIGHT

32. SUPPRESSING THE PLOT (SHOW)

The SHOW function suppresses the drawing of the plot. All other parts of the graph such as legends and point labels are drawn. This feature allows you to combine effects with multiple calls to PLOT that cannot be achieved with a single call to PLOT. The syntax is,

```
      SHOW [ON|OFF]
      SHOW ''
[0|1]
```



EXAMPLE 39: USING SHOW OFF TO VARY SIZE OF TEXT

In EXAMPLE 39, SHOW OFF is used to achieve a different text size for point labels and the footnote.

33. SUPPRESSING OUTLINES (EDGE)

The EDGE function is used to select whether the outline of a solid object is suppressed. You can use this feature with multiple calls to PLOT to draw the outline of solid plots in a different color from the corresponding hatching.

34. CLEARING OR PAUSING BETWEEN PLOTS (CLEAR, TWITCH)

For applications where screen graphics are used, CLEAR and TWITCH cause a screen clear and pause after completion, respectively. This is useful where several PLOT calls comprise a plot. CLEAR ON would be used in the first plot only, while TWITCH ON would be used in the last plot.

CLEAR ON

screen clear at start of PLOT.

CLEAR OFF

don't clear screen at beginning of PLOT.

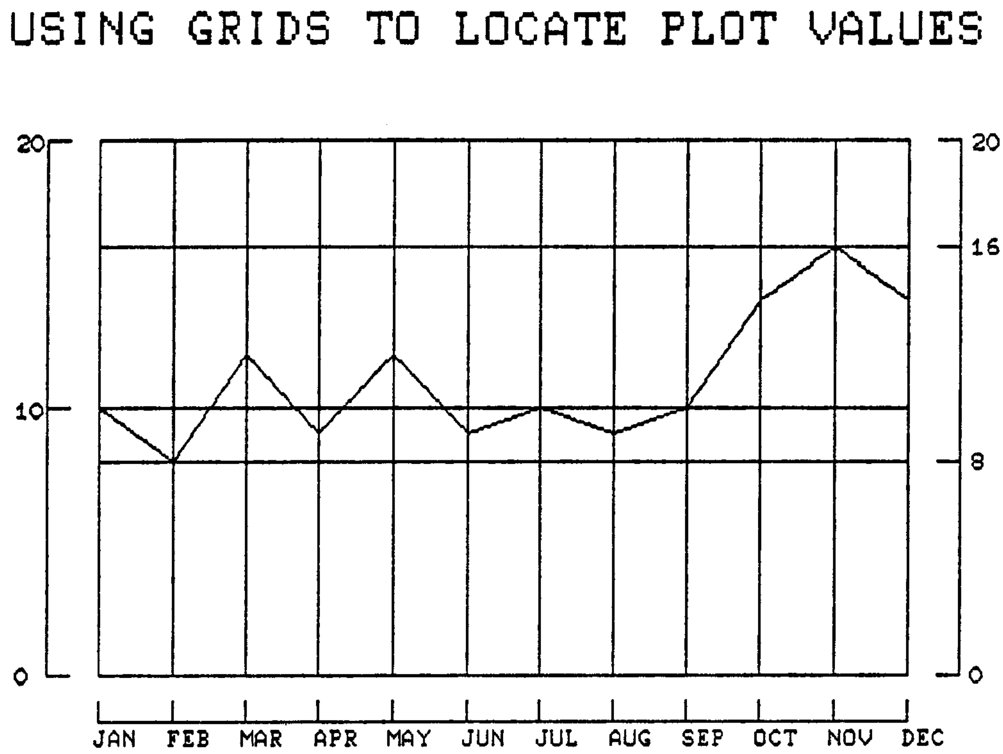
TWITCH ON

pause for carriage return at end of PLOT.

TWITCH OFF

don't pause at end of PLOT.

The use of the CLEAR and TWITCH settings is demonstrated in EXAMPLE 39.



EXAMPLE 40: USING GRIDS TO LOCATE PLOT VALUES

35. DRAWING GRAPH LINES (GRID)

The GRID function causes a grid to be drawn in the region defined by AREA, and its use is analogous to the TIKS function. For example,

```
'X' GRID 10
```

draw 10 equidistant x axis grid lines.

```
'YL' GRID 3 5 7
```

draw three y axis grid lines at positions 3, 5, and 7.

```
'YR' GRID 20
```

when used together with the previous state setting, draws an additional y axis grid at 20 equidistant positions.

Using the 'XT', 'XB', 'YL', or 'YR' commands with GRID provides a simple way to draw two overlapping grids. In EXAMPLE 40, the 'YR' command is used to specify equally spaced grid lines, while the 'YL' command is used to mark particular values of interest.

APPENDIX 1: FRESCO State Vector

[1] APL on/off
[2] 'XT' LABEL on/off
[3] 'XB' LABEL on/off
[4] 'X' LIMS x1 value
[5] 'Y' LIMS y1 value

[6] 'X' LIMS x2 value
[7] 'Y' LIMS y2 value
[8] STYLE value (0-11)
[9] DASH EFFECT on/off
[10] HATCH EFFECT on/off

[11] PICS EFFECT on/off
[12] 'T' TITLE on/off
[13] 'YL' TITLE on/off
[14] 'YR' TITLE on/off
[15] 'YL' TIKS on/off

[16] 'YR' TIKS on/off
[17] 'A' SIZE value
[18]
[19] 'YL' LABEL on/off
[20] 'YR' LABEL on/off

[21] LEGEND on/off
[22] 'XT' DIST value
[23] 'XB' DIST value
[24] 'L' LABEL on/off
[25]

[26] SPEED value
[27] 'X' ROTATE value
[28] 'XT' TITLE on/off
[29] 'XB' TITLE on/off
[30] BORDER on/off

[31] RESULT on/off
[32] BASE on/off
[33] 'A' DIST value
[34]
[35] default pen value

[36] PASS EFFECT on/off
[37] XCOL on/off
[38]
[39] SPLIT on/off
[40] 'X' SPLIT p1 value

[41] 'Y' SPLIT p1 value
[42] 'X' SPLIT p2 value
[43] 'Y' SPLIT p2 value
[44] SMOOTH EFFECT on/off
[45] AREA x1 value

[46] AREA y1 value
[47] AREA x2 value
[48] AREA y2 value
[49]
[50] 'YL' DIST value

[51] 'YR' DIST vale
[52] SHOW on/off
[53] 'L' DIST x value
[54] 'L' DIST y value
[55] 'P' LABEL on/off

[56] EDGE on/off
[57] 'T' DIST value
[58] 'P' SIZE value
[59] 'XT' TIKS on/off
[60] 'XB' TIKS on/off

[61] 'C' SIZE x value
[62] 'C' SIZE y value
[63] 'T' SIZE x value
[64] 'T' SIZE y value
[65] FRAME on/off

[66] 'L' SIZE p1 value
[67] 'L' SIZE p2 value
[68] UPRIGHT on/off
[69] 'YL' GRID on/off
[70] 'YR' GRID on/off

[71] DIVIDER x1 value
[72] DIVIDER y1 value
[73] DIVIDER x2 value
[74] DIVIDER y2 value
[75] 'L' TITLE on/off

[76] PAGE x value
[77] PAGE value
[78] 'LL' TITLE on/off
[79] 'LR' TITLE on/off
[80] ORIGIN value

[81] CLEAR on/off
[82] BLIND EFFECT on/off
[83] CUTOFF value
[84] 'UR' TITLE on/off
[85] 'UL' TITLE on/off

[86] 'P' ROTATE value
[87] STACK on/off
[88] RATIO value
[89] 'XT' GRID on/off
[90] 'XB' GRID on/off

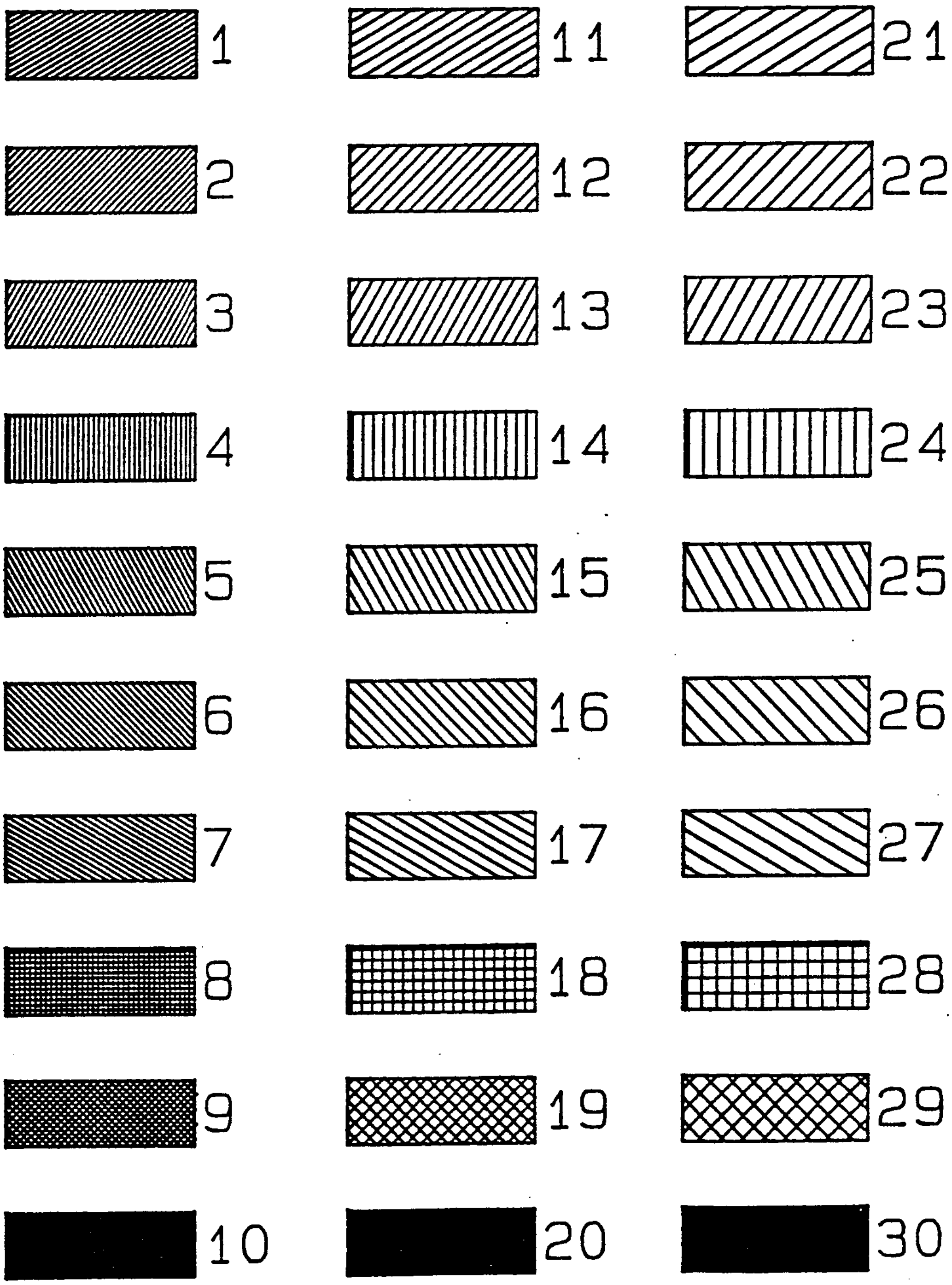
[91] TWITCH on/off
[92]
[93] edging use default pen
[94]
[95]

[96] TTY port value
[97] smart HPGL plotter on/off
[98] ON value
[99] OFF value
[100] scaling value

APPENDIX II: FRESCO 'HATCH' EFFECT PATTERNS

FRESCO uses firmware device-dependent features when available to generate 'HATCH' patterns. Accordingly, 'HATCH' patterns may vary depending on the output device.

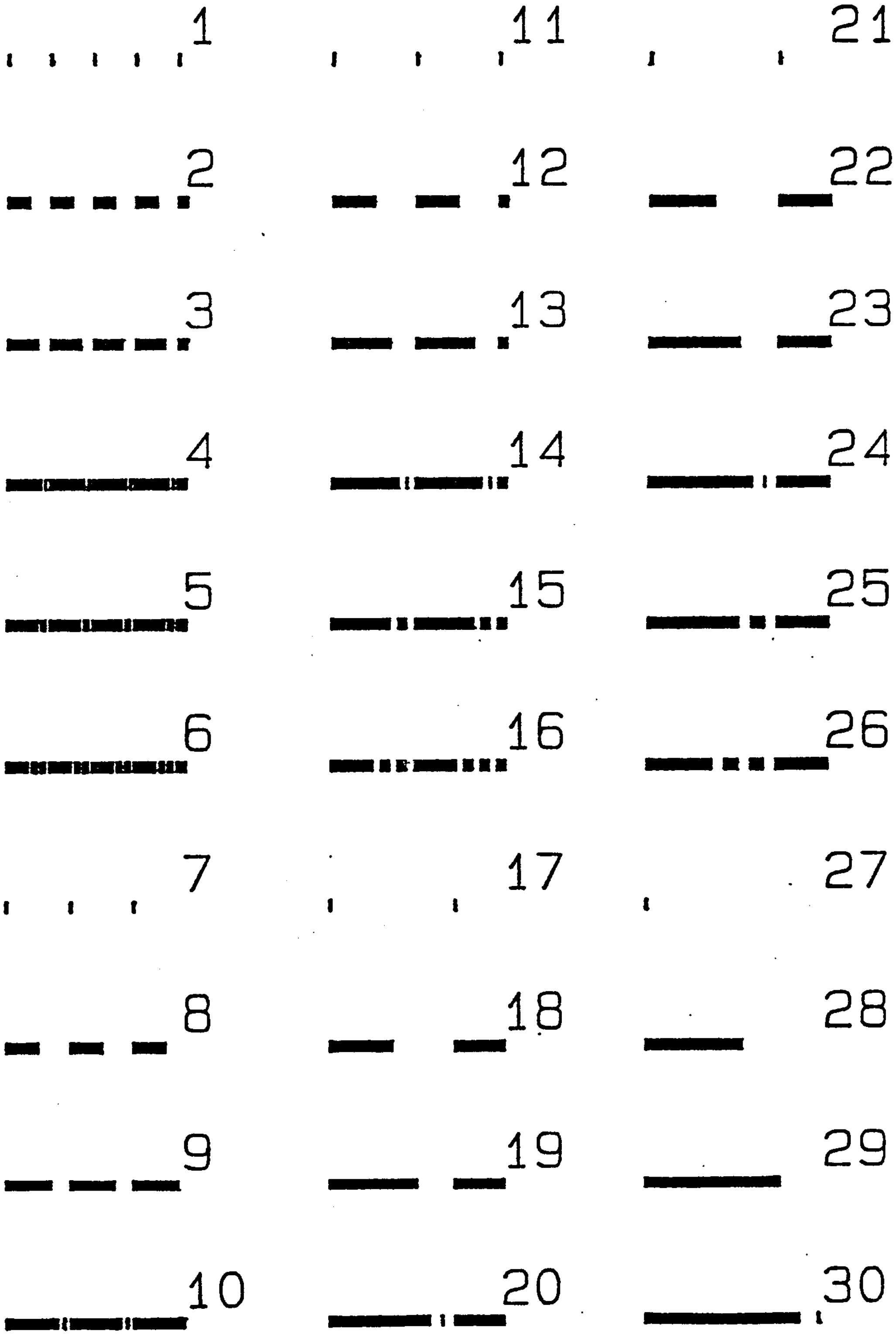
FRESCO HATCHING PATTERNS



APPENDIX III: FRESCO 'DASH' EFFECT PATTERNS

FRESCO uses firmware device-dependent features when available to generate dash patterns. Accordingly, 'DASH' patterns may vary depending on the output device.

FRESCO DASHING PATTERNS



APPENDIX IV: FRESCO 'PICS' EFFECT SYMBOLS

FRESCO uses firmware device-dependent features when available to generate 'PICS' symbols. Accordingly, 'PICS' symbols may vary depending on the output device.

FRESCO PICTURES

~~1 1 1~~ 1

~~2 2 2~~ 2

~~3 3 3~~ 3

~~4 4 4~~ 4

~~5 5 5~~ 5

~~6 6 6~~ 6

~~7 7 7~~ 7

~~8 8 8~~ 8

~~9 9 9~~ 9

~~0 0 0~~ 10

~~A A A~~ 11

~~B B B~~ 12

~~C C C~~ 13

~~D D D~~ 14

~~E E E~~ 15

~~F F F~~ 16

~~G G G~~ 17

~~H H H~~ 18

~~I I I~~ 19

~~J J J~~ 20

~~K K K~~ 21

~~L L L~~ 22

~~M M M~~ 23

~~N N N~~ 24

~~O O O~~ 25

~~P P P~~ 26

~~Q Q Q~~ 27

~~R R R~~ 28

~~S S S~~ 29

~~T T T~~ 30

APPENDIX V: FRESCO EXAMPLES

EXAMPLE 1

```
DEFAULT
'T' TITLE '/TOP TITLE'
'T' DIST 0.5
'UL' TITLE '/UPPER LEFT TITLE'
'UR' TITLE '/frame around the page'
'LL' TITLE '/April 1, 1990'
'LR' TITLE '/Produced using FRESCO'
'YL' TIKS 5
'XB' TIKS 10
'YL' LABEL 1 2 3 4 5
'XB' LABEL 1 2 3 4 5 6 7 8 9 10
'YL' TITLE '/Y AXIS LEFT TIKS AND LABELS'
'XB' TITLE '/X AXIS BOTTOM TIKS AND LABELS'
'XB' DIST 0.1
'XT' TITLE '/border around the plot-area'
'XT' DIST 0.1
'YR' TITLE '/   x  axis   grid   line'
'YR' DIST-0.9
LEGEND ON
'L' TITLE '/   LEGEND TITLE/'
'L' LABEL '/LEGEND LABEL'
'L' SIZE 0.25,0.1
'L' DIST 0.5,-0.4
'P' LABEL '//POINT  LABEL///plot'
FRAME ON
BORDER ON
BASE ON
'X' GRID 10
'Y' GRID 5
PLOT DATA
```

EXAMPLE 2

```
DEFAULT
'T' TITLE '/PLOT USING DEFAULT STATE'
PLOT IBM
```

EXAMPLE 3

```
DEFAULT
'T' TITLE '/LINEPLOT'
PLOT IBM
```

EXAMPLE 4

```
DEFAULT
STYLE 'HISTO1'
'T' TITLE '/HISTO1'
PLOT IBM
```

EXAMPLE 5

```
DEFAULT
STYLE 'HISTO2'
'T' TITLE '/HISTO2'
PLOT IBM
```

EXAMPLE 6

```
DEFAULT
STYLE 'HISTO3'
'T' TITLE '/HISTO3'
PENS 1 1
'Y' LIMS 900 1150
LEGEND ON
'L' LABEL '/INCOME/EXPENSE'
'L' DIST 0 0
'HATCH' EFFECT 1 2
PLOT INCOME,EXPENSE
```

EXAMPLE 7

```
DEFAULT
STYLE 'HISTO4'
'T' TITLE '/HISTO4'
PLOT IBM
```

EXAMPLE 8

```
DEFAULT
STYLE 'HISTO5'
'T' TITLE '/HISTO5'
PLOT IBM
```

EXAMPLE 9

```
DEFAULT
STYLE 'SQUAREPLOT'
'T' TITLE '/SQUAREPLOT'
PLOT INVENTORY
```

EXAMPLE 10

```
DEFAULT
STYLE 'HILOCLOSE'
'T' TITLE '/HILOCLOSE'
'Y' LIMS 80 110
PLOT MARKET
```

EXAMPLE 11

```
DEFAULT
STYLE 'PIECHART'
'T' TITLE '/PIECHART'
PENS 1
'P' LABEL REVENUE[;1]
PLOT REVENUE
```

EXAMPLE 12

```
DEFAULT
STYLE 'SCATTERGRAM'
'T' TITLE '/SCATTERGRAM'
XCOL ON
'X' LIMS 0 100
'Y' LIMS 0 100
PENS 1
'PICS' EFFECT 26
PLOT SURVEY
```

EXAMPLE 13

```
DEFAULT
STYLE 'OBJECT'
'T' TITLE '/OBJECT'
PLOT OCTAGON
```

EXAMPLE 14

```
DEFAULT
'T' TITLE '/SETTING AXIS LIMITS'
'X' LIMS 1 12
'Y' LIMS 0 1200
'XT' TIKS 12
'XT' LABEL MONTHS
'YL' TIKS 13
'YL' LABEL 100×¯1+⍳13
PLOT SALES
```

EXAMPLE 15

```
DEFAULT
'T' TITLE '/HATCH EFFECT WITH MULTIPLE LINEPLOTS'
STYLE 'LINEPLOT'
'HATCH' EFFECT 1 2 1
PENS 1
PLOT+\PRODUCTION
```

EXAMPLE 16

```
DEFAULT
'T' TITLE '/HATCH EFFECT WITH HISTO1'
STYLE 'HISTO1'
'HATCH' EFFECT 1 2 1
PENS 1
PLOT+\PRODUCTION
```

EXAMPLE 17

```
DEFAULT
'T' TITLE '/HATCH EFFECT WITH HISTO2'
STYLE 'HISTO2'
'HATCH' EFFECT 1 2 1
PENS 1
PLOT+\PRODUCTION
```

EXAMPLE 18

```
DEFAULT
'T' TITLE '/HATCH EFFECT WITH HISTO3'
STYLE 'HISTO3'
PENS 1
PLOT+\PRODUCTION
```

EXAMPLE 19

```
DEFAULT
'T' TITLE '/HATCH EFFECT WITH MULTIPLE SQUAREPLOTS'
STYLE 'SQUAREPLOT'
'HATCH' EFFECT 1 2 1
PENS 1
PLOT+\PRODUCTION
```

EXAMPLE 20

```
DEFAULT
STYLE 'PIECHART'
'T' TITLE '/PIECHART'
PENS 1
'P' LABEL REVENUE[;1]
LEGEND ON
'L' LABEL PRODUCTS
'L' DIST- 1 0
'L' SIZE 1 0.25
'C' SIZE 0.2 0.4
PLOT REVENUE
```

EXAMPLE 21

```
DEFAULT
'T' TITLE '/DASH EFFECT'
STYLE 'LINEPLOT'
'DASH' EFFECT 0 1 3
PENS 1
PLOT PRODUCTION
```

EXAMPLE 22

```
DEFAULT
'T' TITLE '/PASS EFFECT'
STYLE 'LINEPLOT'
'PASS' EFFECT 1 2 3
PENS 1
PLOT PRODUCTION
```

EXAMPLE 23

```
DEFAULT
'T' TITLE '/SMOOTH EFFECT'
STYLE 'LINEPLOT'
'SMOOTH' EFFECT 0 2 5
PENS 1
PLOT PRODUCTION
```

EXAMPLE 24

```
DEFAULT
'T' TITLE '/BLIND EFFECT AND CUTOFF'
'BLIND' EFFECT 5
CUTOFF 15
'Y' LIMS 10 15
PLOT OPTION
```

EXAMPLE 25

```
DEFAULT
'T' TITLE '/USING XCOL ON WITH OMITTED VALUES'
XCOL ON
'Y' LIMS 10 15
PLOT(OPTION<15)/[1](ιρOPTION),[1.5]OPTION
```

EXAMPLE 26

```
DEFAULT
'T' TITLE '/PICS EFFECT'
'PICS' EFFECT 26
PLOT INVENTORY
```

EXAMPLE 27

```
DEFAULT
'T' TITLE '/EQUIDISTANT X AND Y AXIS TICKS'
'X' TIKS 12
'Y' TIKS 20
'Y' LIMS 0 20
PLOT INVENTORY
```

EXAMPLE 28

```
DEFAULT
'T' TITLE '/Y TICKS WITH VARIABLE WIDTH'
'Y' TIKS(0,ι20),[1.5]21ρ 1 0.5
'Y' LIMS 0 20
PLOT INVENTORY
```

EXAMPLE 29

```
DEFAULT
'T' TITLE '/LOGARITHMIC Y TICKS'
'Y' TIKS⍟10×ι12
'Y' LIMS⍟ 10 120
'Y' LABEL 10×ι12
PLOT⍟OPTION
```

EXAMPLE 30

```
DEFAULT
'T' TITLE '/X AND YL LABELS'
'X' LIMS 1 12
'Y' LIMS 1000 1100
'X' TIKS 12
'X' LABEL MONTHS
'YL' TIKS 11
'YL' LABEL 1000+0,10×ι10
PLOT SALES
```

EXAMPLE 31

```
DEFAULT
'T' TITLE '/POINT LABELS'
'P' LABEL SALES
PLOT SALES
```

EXAMPLE 32

```
DEFAULT
'T' TITLE '/"MAIN TITLE"'
'L' TITLE '/"LEGEND TITLE"'
LEGEND ON
'L' LABEL FUELS
'XT' TITLE '/"XT TITLE"'
'XB' TITLE '/"XB TITLE"'
'YL' TITLE '/"YL TITLE"'
'YR' TITLE '/"YR TITLE"'
'UL' TITLE '/"UL TITLE"'
'UR' TITLE '/"UR TITLE"'
'LL' TITLE '/"LL TITLE"'
'LR' TITLE '/"LR TITLE"'
BORDER ON
FRAME ON
'DASH' EFFECT 0 1 3
PENS 1
'Y' LIMS 0 20
'Y' TIKS 21
'Y' LABEL 0,⍳20
'X' TIKS 12
'X' DIST 0.6
AREA 1 1 0.75 0.875 ×AREA ''
PLOT PRODUCTION
```

EXAMPLE 33

```
DEFAULT
'T' TITLE '/T DIST 1'
'T' DIST 1
'L' TITLE '/L DIST 1'
'L' DIST 1
'XB' TITLE '/A DIST 1 - XB DIST 1'
'XB' DIST 1
'Y' TITLE '/A DIST 1 - Y DIST 1'
'Y' DIST 1
'A' DIST 1
'R' DIST 1
LEGEND ON
'L' LABEL FUELS
'DASH' EFFECT 0 1 3
PENS 1
'Y' LIMS 0 21
'Y' TIKS(0,ι21),[1.5]0.2
'XB' TIKS(ι10),[1.5]0.2
TWITCH OFF
PLOT PRODUCTION
TWITCH ON
SHOW ON
CLEAR OFF
'T' TITLE '/T DIST 0'
'T' DIST 0
'L' TITLE '/L DIST 0'
'L' DIST 0
'XB' TITLE '/A DIST 0 - XB DIST 0'
'XB' DIST 0
'Y' TITLE '/A DIST 0 - Y DIST 0'
'Y' DIST 0
'A' DIST 0
'R' DIST 0
PLOT PRODUCTION
```

EXAMPLE 34

```
DEFAULT
'T' TITLE '/T SIZE .1 .2'
'T' SIZE 0.1 0.2
'T' DIST 1
'L' TITLE '/L SIZE .75 .25'
'L' SIZE 0.75 0.25
'L' DIST 3 0
'XB' TITLE '/A SIZE .4'
'A' SIZE 0.4
'A' DIST 0
'XB' DIST 0.5
LEGEND ON
'L' LABEL FUELS
'DASH' EFFECT 0 1 3
PENS 1
'Y' LIMS 0 21
'XB' TIKS(⍳10),[1.5]10⍴ 1 0.25 0.5 0.25
TWITCH OFF
PLOT PRODUCTION
SHOW OFF
CLEAR OFF
'T' TITLE '/T SIZE .2 .4'
'T' SIZE 0.2 0.4
'T' DIST 0.5
'L' TITLE '/L SIZE .25 .75'
'L' SIZE 0.25 0.75
'L' DIST 0
'XB' TITLE '/A SIZE .2'
'A' SIZE 0.2
'A' DIST 0.675
'XB' DIST 1
PLOT PRODUCTION
TWITCH ON
'T' TITLE OFF
LEGEND OFF
'XB' TITLE OFF
'UL' TITLE '/C SIZE .1 .2'
'C' SIZE 0.1 0.2
PLOT PRODUCTION
```

EXAMPLE 35

```
DEFAULT
STYLE 'PIECHART'
'T' DIST 0
'T' TITLE '/REVENUE'
'X' SPLIT 0 0.5
'Y' SPLIT 0.5 1
PENS 1
'P' LABEL PRODUCTS
'P' SIZE 2
TWITCH OFF
PLOT REVENUE

'T' TITLE '/COST'
'X' SPLIT 0.5 1
CLEAR OFF
PLOT COST

'T' TITLE '/UNITS SOLD'
'Y' SPLIT 0 0.5
PLOT UNITS

'T' TITLE '/STOCK ON HAND'
'X' SPLIT 0 0.5
TWITCH ON
PLOT STOCK
```

EXAMPLE 36

```
DEFAULT
'T' SIZE 0.1 0.2
'T' DIST 0.3
'UL' TITLE '/FRAME'
'XB' TITLE '/BORDER'
'XB' DIST 0.1
'T' TITLE '/X SPLIT 0.0 0.5/Y SPLIT 0.5 1.0'
'X' SPLIT 0 0.5
'Y' SPLIT 0.5 1
BORDER ON
FRAME ON
TWITCH OFF
PLOT IBM
CLEAR OFF
'X' SPLIT 0.5 1
'T' TITLE '/X SPLIT 0.5 1.0/Y SPLIT 0.5 1.0'
PLOT IBM
'Y' SPLIT 0 0.5
'T' TITLE '/X SPLIT 0.0 1.0/Y SPLIT 0.0 0.5'
PLOT IBM
'X' SPLIT 0 0.5
'T' TITLE '/X SPLIT 0.0 0.5/Y SPLIT 0.0 0.5'
TWITCH ON
PLOT IBM
```

EXAMPLE 37

```
DEFAULT
DIVIDER 0 0.5 1 0.5
'T' TITLE '/DIVIDER 0.0 0.5 1.0 0.5'
'T' DIST ¯2.4
'T' SIZE 0.1 0.2
TWITCH OFF
SHOW OFF
PLOT ''

'T' DIST 0.3
'T' TITLE '/X SPLIT 0.0 0.5/Y SPLIT 0.5 1.0'
'X' SPLIT 0 0.5
'Y' SPLIT 0.5 1
SHOW ON
CLEAR OFF
PLOT IBM

'LL' TITLE OFF
'X' SPLIT 0.5 1
'T' TITLE '/X SPLIT 0.5 1.0/Y SPLIT 0.5 1.0'
PLOT IBM

'Y' SPLIT 0 0.5
'T' TITLE '/X SPLIT 0.0 1.0/Y SPLIT 0.0 0.5'
PLOT IBM

'X' SPLIT 0 0.5
'T' TITLE '/X SPLIT 0.0 0.5/Y SPLIT 0.0 0.5'
TWITCH ON
PLOT IBM
```

EXAMPLE 38

```
DEFAULT
STYLE 'HISTO3'
'T' TITLE '/UPRIGHT ON'
UPRIGHT ON
PENS 1 1
'Y' LIMS 900 1150
LEGEND ON
'L' DIST 5 0
'L' LABEL '/INCOME/EXPENSE'
PLOT INCOME,EXPENSE
```

EXAMPLE 39

```
DEFAULT
'T' TITLE '/USING SHOW OFF TO VARY SIZE OF TEXT'
'P' LABEL SALES
'C' SIZE 0.2 0.4
TWITCH OFF
PLOT SALES
TWITCH ON
CLEAR OFF
'C' SIZE 0.1 0.2
SHOW OFF
'P' LABEL OFF
'LL' TITLE '\ASUF&G 1992 10 3/4% UNSECURED BONDS'
PLOT ''
```

EXAMPLE 40

```
DEFAULT
'T' TITLE '/USING GRIDS TO LOCATE PLOT VALUES'
'XB' GRID 12
'XB' TIKS 12
'XB' LABEL MONTHS
'YL' GRID 3
'YL' TIKS 3
'YL' LABEL 0 10 20
A←(⌈/INVENTORY),⌊/INVENTORY
'YR' GRID A
A←0,A,20
'YR' TIKS A
'YR' LABEL A
'Y' LIMS 0 20
PLOT INVENTORY
```

```
COST←5 2ρ
 3   0
 5   0
 3   0.5
 7   0
 8   0

DATA←10ρ1 2.5 1 1.5 2.5 5 3 4.5 5 3

DAYS←64ρ'/NOV 2/NOV 3/NOV 4/NOV 5. . .'

EXPENSE←12 1ρ
 1010
 1028
 1001
 1042
 1003
 1071
 1094
 1024
 1019
 1032
 1089
 1066

FUELS←21ρ'/COAL/ELECTRICITY/OIL'

IBM←12ρ109 107 108 108 110 109 103 104 104 106 106 109

INCOME←12 1ρ
 1010
 1034
 1001
 1041
 1008
 1071
 1102
 1027
 1024
 1040
 1088
 1070

INVENTORY←12ρ10 8 12 9 12 9 10 9 10 14 16 14
```

```
MARKET←92 3ρ
 105 101 105
 104 101 102
 104 101 102
 106 102 106
 104 102 104
 106 102 105
 . . .

MONTHS←12 3ρ
'JAN'
'FEB'
'MAR'
'APR'
'MAY'
'JUN'
'JUL'
'AUG'
'SEP'
'OCT'
'NOV'
'DEC'

OCTAGON←9 2ρ
 3.2 1
 3.2 2.4
 4.2 3.4
 5.6 3.4
 6.6 2.4
 6.6 1
 5.6 0
 4.2 0
 3.2 1

OPTION←100ρ11.13 11.76 11.69 13.02 . . .

PRODUCTION←10 3ρ
 15  8  3
  8  4  1
  6  3  1
 11  6  2
  3  2  1
  9  5  2
 12  6  2
 17 10  4
 19 11  4
 11  6  2

PRODUCTS←30ρ'/VALVES/TANKS/PIPE/PUMPS/OTHER'
```

```
REVENUE←5 2ρ
 3   0
 5   0
 8   0.5
 7   0
 8   0


SALES←6ρ1073 1050 1006 1045 1052 1078

STOCK←5 2ρ
 3   0
 5   0
 2   0.5
 7   0
 8   0

SURVEY←50 2ρ
 19 12
 72 62
 28 32
 59 63
 22 23
  0  0
  1  0
 43 48
 68 62
 .  .  .

UNITS←5 2ρ
 3   0
 5   0
 5   0.5
 7   0
 8   0
```

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